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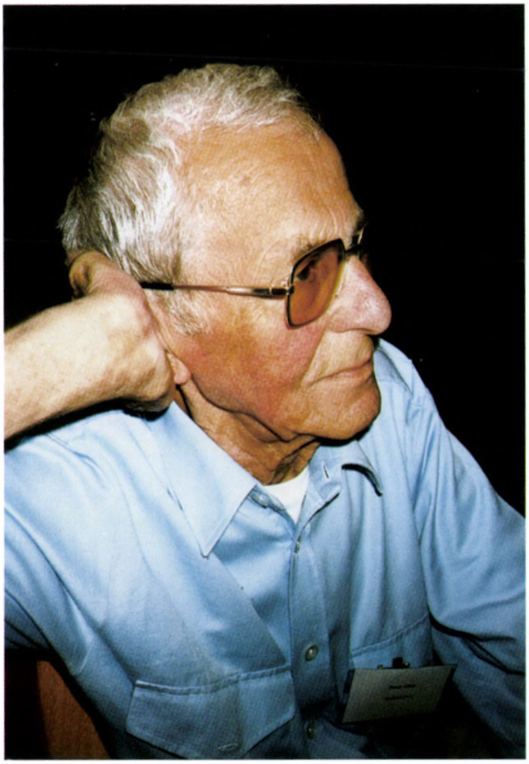
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Neuropterology 2000

Proceedings of the
Seventh International Symposium
on Neuropterology

6–9 August, 2000
Budapest, Hungary

Edited by
GYÖRGY SZIRÁKI



This proceedings volume is respectfully dedicated to the memory of
Dr. PETER OHM
(9 September 1922 – 18 July 2001)

PREFACE

As a result of the decision made at the meeting in Helsinki, the Seventh International Symposium on Neuropterology was held from 6th to 9th August 2000 at Csillebérc, in a forested hilly part of the Hungarian capital, Budapest. About thirty registered scientists, representing 19 countries took part on the meeting where 23 lectures and 21 posters were presented.

The presentations covered all areas of research into Neuropteroidea, including anatomy, applied entomology, biogeography, biology, ecology, faunistics, external morphology, systematics and taxonomy; most of them are included in this proceedings volume, entitled "Neuropterology 2000".

In addition to the formal presentations, a round-table discussion on the phylogeny of Neuropteroidea was organized, with Dr. ULRIKE ASPÖCK in the chair. Another round-table discussion on current and future projects and research themes was conducted, as usual, by Professor HORST ASPÖCK.

At the meeting of the International Association for Neuropterology, Professor HORST ASPÖCK and Dr. ULRIKE ASPÖCK were elected as co-presidents for the period of 2000–2003.

The scientific event was followed by a post-congress tour to some interesting areas of Hungary, with nice landscape and peculiar natural and seminatural habitats. A report on this excursion is included in this volume.

The symposium was organized by the Hungarian Natural History Museum. However, the contributions of many other persons were necessary to make the event successful. In particular, Dr. FERENC SZENTKIRÁLYI (Plant Protection Institute, Hungarian Academy of Sciences) participated in many steps of the organization while his wife, Mrs JUDIT TÓTH, arranged the programme for the accompanying persons. Dr. LEVENTE ÁBRAHÁM (Somogy County Museum) and Prof. VILMOS ALTBÄCKER (Eötvös Loránd University) helped us during the course of the post-congress tour.

Participants of the symposium accepted the proposal of Dr. JOHN OSWALD that the next symposium should take place in Texas, USA, during 2003. The organizers of the meeting held in Budapest wish all neuropterologists valuable new results in the years to come and their American colleagues every success in organizing the Eighth Symposium.

Budapest, May 2001

György Sziráki

AVANT-PROPOS

Comme convenu lors de la précédente réunion d'Helsinki, le Septième Symposium International de Névroptérologie a eu lieu à Csillebérc, dans un site collinéen couvert de forêts de la capitale hongroise, Budapest, du 6 au 9 août de l'an 2000. Au total, trente spécialistes représentant 19 pays se sont réunis pour présenter 23 communications orales et 21 posters.

Les présentations ont abordé tous les sujets de recherche concernant les Neuropteroidea: anatomie, biogéographie, biologie, écologie, entomologie appliquée, faunistique, morphologie externe, systématique et taxonomie. La plupart d'entre elles paraîtront dans la publication à venir sous le titre "Neuropterology 2000". Aux contributions traditionnelles se sont ajoutées une table ronde relative à la phylogénie des Neuropteroidea animée par Mme ULRIKE ASPÖCK, Dr, ainsi qu'une discussion relative aux thèmes de recherches actuelles et futures, animée et présidée comme à l'accoutumé par Mr le professeur HORST ASPÖCK.

Pendant l'assemblée générale statutaire de l'Association Internationale de Névroptérolgie, Mr le Professeur HORST ASPÖCK et Mme ULRIKE ASPÖCK, Dr, ont été conjointement élus présidents pour la durée du nouveau mandat, la période 2000–2003.

La conférence scientifique a été prolongée par une excursion post congrès des participants vers quelques sites intéressants et spectaculaires de Hongrie, y compris vers de curieux biotopes naturels. Un bref aperçu de cette sortie amicale sera aussi inséré dans le volume des comptes rendus.

Le symposium a été organisé par le Musée Hongrois d'Histoire Naturelle. Toutefois, la contribution de nombreuses autres personnes a été indispensable pour en assurer l'entière réussite. Mr FERENC SZENTKIRÁLYI, Dr (Institut de la Protection des Plants de l'Académie Hongroise des Sciences), a participé de diverses manières à l'organisation de la conférence, sa femme, Mme JUDIT TÓTH a pris en charge les activités destinées aux personnes accompagnantes, tandis que LEVENTE ÁBRAHÁM, Dr (Muséum du Comitat Somogy), and Mr le Professeur VILMOS ALTBÄCKER (Université Eötvös Loránd), ont efficacement contribué à l'organisation de l'excursion.

Les participants du symposium ont accepté la proposition de Mr JOHN OSWALD, Dr, d'accueillir la prochaine conférence au Texas (États-Unis d'Amérique) en l'an 2003. Les organisateurs de la réunion de Budapest souhaitent un plein succès dans leurs entreprises à tous les névroptérologistes pour les années qui viennent ainsi que facilités et réussite aux collègues américains pour l'organisation du huitième symposium.

Budapest, Mai 2001

György Sziráki

VORWORT

Beim 6. Symposium in Helsinki im Juli 1997 wurde der Beschluß gefaßt, das 7. Internationale Symposium für Neuropterologie vom 6–9. August 2000 in Csillebérc, in einem Waldgebiet der ungarischen Hauptstadt, zu veranstalten. Etwa 30 angemeldete Wissenschaftler aus 19 Ländern nahmen an dem Symposium teil, es wurden 23 Vorträge und 21 Poster präsentiert.

Die Präsentationen – von denen die meisten in dem vorliegenden Band zu finden sind – befaßten sich mit vielen Aspekten der Neuropterologie, die Schwerpunkte lagen auf Themen aus den Bereichen der Morphologie, Anatomie, Biologie, Ökologie, angewandte Entomologie, Faunistik, Biogeographie, Taxonomie und Systematik. Die meisten davon sind in dem vorliegenden Band "Neuropterology 2000" zu finden.

Eine Round-Table-Diskussion über die Phylogenie der Neuropterida wurde von Dr. ULRIKE ASPÖCK geleitet, eine weitere Round-Table-Diskussion, und zwar über die gegenwärtigen und künftigen Projekte und Forschungsthemen, wurde, wie immer, von Professor HORST ASPÖCK veranstaltet.

Die International Association of Neuropterology wählte HORST ASPÖCK und ULRIKE ASPÖCK als Co-Präsidenten für die Periode zwischen 2000–2003.

Dem wissenschaftlichen Teil des Programmes folgte eine Exkursion in einige besondere Gebiete Ungarns, schöne Landschaften und weitgehend ursprüngliche Biotope wurden besucht. Dieser Band enthält auch einen Bericht über die Exkursion.

Das Symposium wurde vom Ungarischen Naturwissenschaftlichen Museum organisiert. Zum Erfolg der Konferenz trugen auch Kollegen von anderen Instituten bei: Dr. FERENC SZENTKIRÁLYI (Institut für Pflanzenschutz der Ungarischen Akademie der Wissenschaften) half in vielen Phasen der Organisation, seine Frau, JUDIT TÓTH organisierte das Programm für Begleitpersonen, Dr. LEVENTE ÁBRAHÁM (Museum des Komitates Somogy) und Professor VILMOS ÁLTBECKER (Eötvös Loránd Universität) betreuten mit uns gemeinsam die Exkursion.

Dr. JOHN OSWALD bot an, das nächste Symposium im Jahr 2003 in Texas, USA, zu veranstalten. Der Vorschlag wurde von den Teilnehmern des Symposiums mit Freude angenommen. Die Organisatoren der Konferenz in Budapest wünschen allen Neuropterologen ergebnisreiche Forschungsarbeit und den amerikanischen Kollegen viel Erfolg bei der Organisation des 8. Symposiums in Texas.

Budapest, Mai 2001

György Sziráki

ELŐSZÓ

A neuropterológusok helsinki találkozóján született döntés értelmében a Hetedik Nemzetközi Neuropterológiai Szimpózium 2000. augusztus 6. és 9. között Csillebércen, a magyar főváros, Budapest egyik erdős-hegyes részén, került megrendezésre. A szimpóziumon mintegy harminc regisztrált kutató vett részt, akik tizenkilenc országból érkeztek. A redezvényen 23 előadás hangzott el, és 21 poszter került bemutatásra.

Az előadások és poszterek felölelték a recésszárnyúakon végzett kutatások minden területét, így az anatómiát, biogeográfiát, élettant, ökológiát, alkalmazott rovartant, faunisztikát, külső morfológiát éppúgy, mint a szisztematikát és taxonómiát. Túlnyomó többségüknek az anyaga szerepel jelen kiadványkötetben („Neuropterology 2000") is. A fentieken túl két kerekasztal tanácskozás is szerepelt a programban. Az egyiknek a témája a recésszárnyúak filogenezise volt, és ezt a tanácskozást Dr. ULRIKE ASPÖCK vezette, míg a másik a jelen és a jövő kutatási témáival foglalkozott – szokás szerint HORST ASPÖCK professzor vezényletével.

A Nemzetközi Neuropterológiai Társaság közgyűlésén a 2000-től 2003-ig terjedő időszakra HORST ASPÖCK professzort és Dr. ULRIKE ASPÖCK-öt választották a társaság társelnökeivé.

A rendezvény tudományos része után egy kongresszusi kirándulás következett Magyarország néhány érdekes, tájképi szépségekben és természetközeli élőhelyekben gazdag területére. (A kirándulásról szóló beszámoló is szerepel jelen kötetben.)

A szimpóziumot a Magyar Természettudományi Múzeum rendezte, de mások közreműködésére is szükség volt ahhoz, hogy az esemény sikeres lehessen. Dr. SZENTKIRÁLYI FERENC (MTA Növényvédelmi Kutató Intézet) a rendezés sok lépésében részt vett. Felesége, TÓTH JUDIT az útitársak számára készült programot szervezte és vezette, míg Dr. ÁBRAHÁM LEVENTE (Somogy Megyei Múzeumok) és Dr. ALTBÄCKER VILMOS professzor (Eötvös Loránd Tudományegyetem) a túra során voltak segítségünkre.

A résztvevők elfogadták Dr. JOHN OSWALD javaslatát, hogy a következő szimpózium 2003-ban, Texasban (USA) kerüljön megrendezésre. A budapesti találkozó szervezői minden neuropterológusnak értékes új eredményeket kívánnak az elkövetkező évekre, amerikai kollégáiknak pedig sok sikert a Nyolcadik Szimpózium megszervezésében.

Budapest, 2001 májusa

Sziráki György

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OSMYLIDAE: ILLUSTRATIONS IN THE EARLY ENTOMOLOGICAL LITERATURE AND THE DISCOVERY OF EARLY STAGES AND CLARIFICATION OF THE BIOLOGY (NEUROPTERIDA: NEUROPTERA)

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This paper gives an account of the early research on those insects now included in the family Osmylidae, with detailed information on first descriptions and illustrations, nomenclature of the first described species and genus, on illustrations until 1820 and on the discovery of early stages and of the biology.

Key words: Neuroptera, Osmylidae, history of entomology

INTRODUCTION

Osmylus fulvicephalus (SCOPOLI, 1763) is one of the most conspicuous and largest lacewings in Europe. It has been found in almost all the European countries (ASPÖCK *et al.* 1980, 2001), sometimes being quite abundant.* Nevertheless, this insect, as well as other species of the family Osmylidae, appeared in the entomological literature rather late, and the biology also remained a mystery until the middle of the nineteenth century.

FIRST DESCRIPTION AND FIRST ILLUSTRATION

It is surprising that none of the authors of the famous books on insects published in the 17th and early 18th century – TH. MOUFET (1634), U. ALDROVANDUS (1638), J. JONSTON (1657), J. L. FRISCH (1720–1738), R. A. F. DE REAUMUR (1734–1742), J. SWAMMERDAMM (1752) – mentioned anything about these insects.

To the best of my knowledge the first description was published by A. J. RÖSEL VON ROSENHOF (1755) in the third volume of his famous "Insecten-Be-

* Except for the Caucasus region and the Ukraine, Europe harbours only this species of the family Osmylidae (ASPÖCK *et al.* 2001).

lustigung" (Figs 1–5). In a German that sounds extremely circumstantial and old-fashioned today, he described "die kleine Land-Libelle mit braun-gefleckten breiten Flügeln" (= the small terrestrial dragonfly with brown-spotted broad wings) (Figs 2–3) and he even said that this insect is not rare in his region (i.e. Southern Germany). RÖSEL VON ROSENHOF also provided a beautiful illustration (Figs 4–5), the first in the entomological literature. RÖSEL VON ROSENHOF's son-in-law, C. KLEEMANN, edited a Dutch translation of the "Insecten-Belustigung", and all copper plates were again published, but on much better quality paper than in the German edition, and with broad margins.

NOMENCLATURE

RÖSEL VON ROSENHOF used a very circumstantial German name only; the third volume of his "Insecten-Belustigung" appeared three years before the introduction of binominal nomenclature by LINNAEUS (1758). In LINNAEUS' Editio decima of his "Systema naturae" there is no description of any insect that could be interpreted as an *Osmylus*. The first nomenclaturally valid name is *Hemerobius fulvicephalus* introduced by SCOPOLI (1763) who described and illustrated the insect quite adequately (Figs 6–9). Table 1 shows the synonymy.

The species was often but erroneously called "*Hemerobius chrysops*" ("*Osmylus chrysops*") which is definitely incorrect. When LINNAEUS (1758) introduced the name, he clearly described a chrysopid. It is hardly understandable that even KRÜGER (1912) in his remarkable monograph treated the species as "*Osmylus chrysops*".

The genus *Osmylus* was described by LATREILLE (1802) for *Hemerobius maculatus* FABRICIUS, 1787, by monotypy (OSWALD & PENNY 1991). Interestingly, in the 13th volume of his "Histoire naturelle..." LATREILLE (1805) included not only *Hemerobius maculatus* FABRICIUS, but also *Hemerobius phalaenoides* LINNAEUS, 1758, in this genus. The family was formally established (as Osmylida) by LEACH in BREWSTER (1815), with *Osmylus maculatus* only.

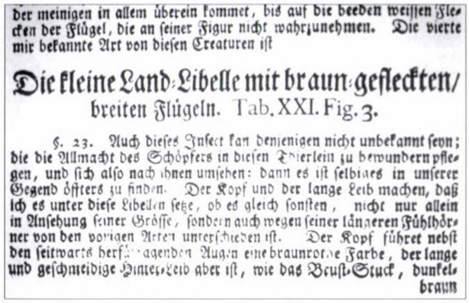
Table 1. Synonyms of *Osmylus fulvicephalus* (SCOPOLI, 1763)

Hemerobius fulvicephalus SCOPOLI, 1763: VILLERS (1789)
Hemerobius chrysops auct. [nec LINNAEUS, 1758]: SULZER (1776), HERBST & SOTZMANN (1786), ROEMER (1789)
Hemerobius maculatus FABRICIUS, 1787
Hemerobius laurifoliaeformis RAZOUMOWSKY, 1789
Osmylus maculatus (FABRICIUS): LATREILLE (1802), GERMAR (1817)



Der
monathlich-herausgegebenen
Insecten-
Belustigung
Dritter Theil
worinnen
usser verschiedenen, zu den in den beeden ersten
Theilen enthaltenen Classen, gehörigen Insecten, auch mancher-
ley Arten von acht neuen Classen
ach ihrem Ursprung, Verwandlung und andern wunderbaren Eigen-
schafften, aus eigener Erfahrung beschrieben, und in sauber illuminirten
Kupfern, nach dem Leben abgebildet vorgestellet werden
von
August Johann Rösel
von Rosenhof.
Nürnberg, zu finden bey dem Verfasser.
Gedruckt bey Johann Joseph Fleischmann,
1755.

1

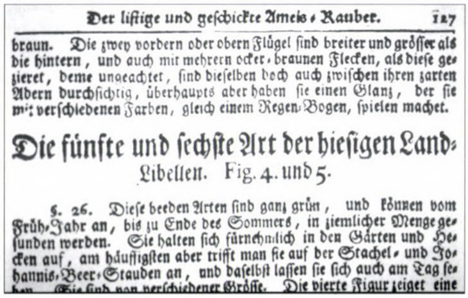


der meinigen in allem überein kommet, bis auf die beeden weissen Fle-
cken der Flügel, die an seiner Figur nicht wahrzunehmen. Die vierte
mir bekannte Art von diesen Creaturen ist

Die kleine Land-Libelle mit braun-gefleckten/ breiten Flügeln. Tab. XXI. Fig. 3.

§. 23. Auch dieses Insect kan denjenigen nicht unbekannt seyn; die die Allmacht des Schöpfers in diesen Thierlein zu bewundern pflegen, und sich also nach ihnen umsehen: dann es ist selbiges in unserer Gegend öffters zu finden. Der Kopf und der lange Leib machen, daß ich es unter diese Libellen setze, ob es gleich sonsten, nicht nur allein in Ansehung seiner Grösse, sondern auch wegen seiner längeren Fühlhörner von den vorigen Arten unterschieden ist. Der Kopf führet nebst den seitwarts herfür-ragenden Augen eine braunrothe Farbe, der lange und geschmeidige Hinter-Leib aber ist, wie das Brust-Stuck, dunkel-braun

2



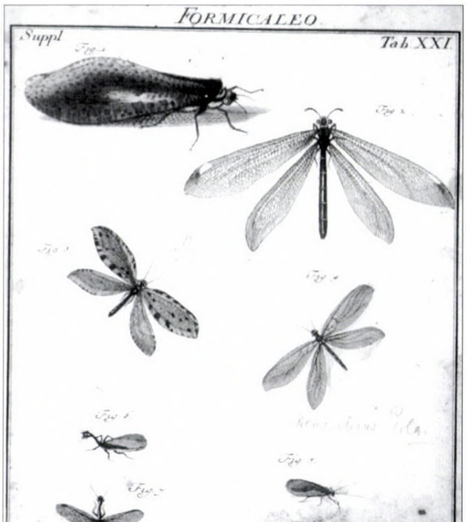
Der listige und geschickte Ameis-Rauber. 127

braun. Die zwey vordern oder obern Flügel sind breiter und grösser als die hintern, und auch mit mehrern ocker-braunen Flecken, als diese gezieret, deme ungeachtet, sind dieselben doch auch zwischen ihren zarten Adern durchsichtig, überhaupts aber haben sie einen Glanz, der sie mit verschiedenen Farben, gleich einem Regen-Bogen, spielen machet.

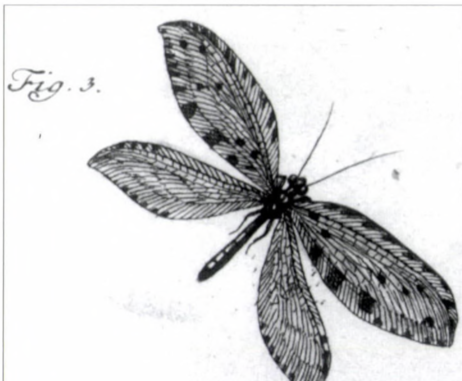
Die fünfte und sechste Art der hiesigen Land-Libellen. Fig. 4. und 5.

§. 26. Diese beeden Arten sind ganz grün, und können vom Früh-Jahr an, bis zu Ende des Sommers, in ziemlicher Menge ge-sunden werden. Sie halten sich fürnehmlich in den Gärten und Hecken auf, am häufigsten aber trifft man sie auf der Stachel- und Johannis-Beer-Stauden an, und daselbst lassen sie sich auch am Tag se-hen. Sie sind von verschiedener Grösse. Die vierte Figur zeiget eine

3

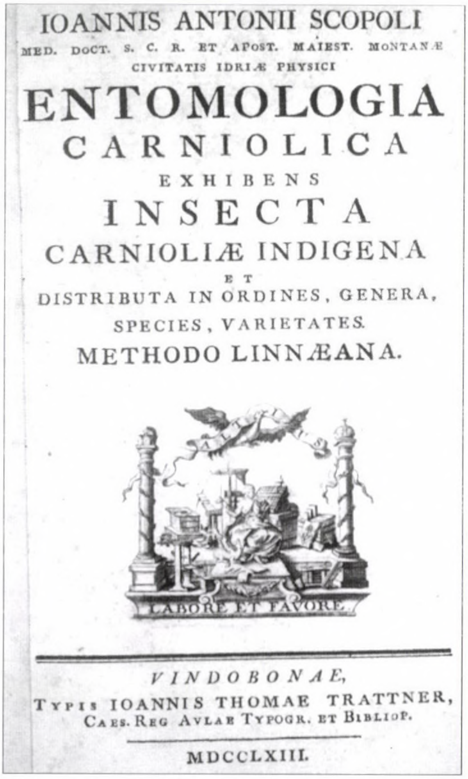


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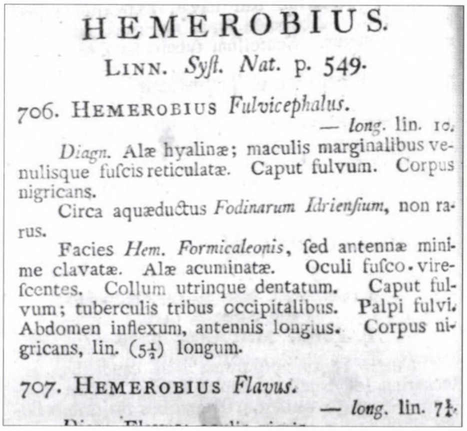
Figs 1–5. 1 = RÖSEL VON ROSENHOF (1755): Title page (Library H. & U. ASPÖCK); 2–3 = RÖSEL VON ROSENHOF (1755): Description of "Die kleine Land-Libelle…" (Library H. & U. ASPÖCK); 4 = RÖSEL VON ROSENHOF (1755): Plate XXI, suppl. (vol. 3) with the insect today known as *Osmylus fulvicephalus* (Library H. & U. ASPÖCK); 5 = RÖSEL VON ROSENHOF (1755): Detail of Plate XXI, Suppl. (Fig. 3) (Library H. & U. ASPÖCK)


IOANNIS ANTONII SCOPOLI
MED. DOCT. S. C. R. ET APOST. MAIEST. MONTANÆ
CIVITATIS IDRIÆ PHYSICI
ENTOMOLOGIA
CARNIOLICA
EXHIBENS
INSECTA
CARNIOLIÆ INDIGENA
ET
DISTRIBUTA IN ORDINES, GENERA,
SPECIES, VARIETATES.
METHODO LINNÆANA.

LABORE ET FAVORE.

VINDOBONAE,
TYPIS IOANNIS THOMAE TRATTNER,
CAES. REG AVLAE TYPOGR. ET BIBLIOP.
MDCCLXIII.

6


HEMEROBIUS.
LINN. *Syst. Nat.* p. 549.

706. HEMEROBIUS *Fulvicephalus.*
— *long.* lin. 10.

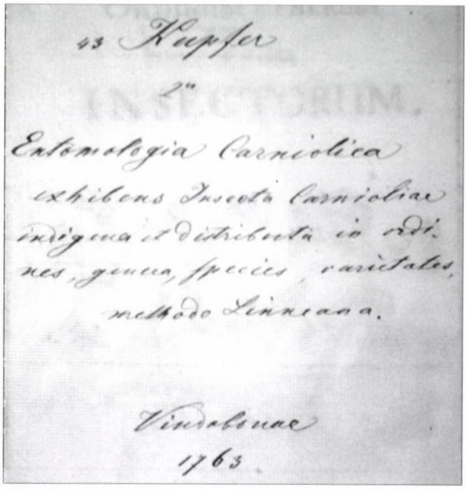
Diagn. Alæ hyalinæ; maculis marginalibus venulisque fuscis reticulatæ. Caput fulvum. Corpus nigricans.

Circa aquæductus *Fodinarum Idriensium*, non rarus.

Facies *Hem. Formicaleonis*, sed antennæ minime clavatæ. Alæ acuminatæ. Oculi fusco-virescentes. Collum utrinque dentatum. Caput fulvum; tuberculis tribus occipitalibus. Palpi fulvi. Abdomen inflexum, antennis longius. Corpus nigricans, lin. (5½) longum.

707. HEMEROBIUS *Flavus.*
— *long.* lin. 7½.

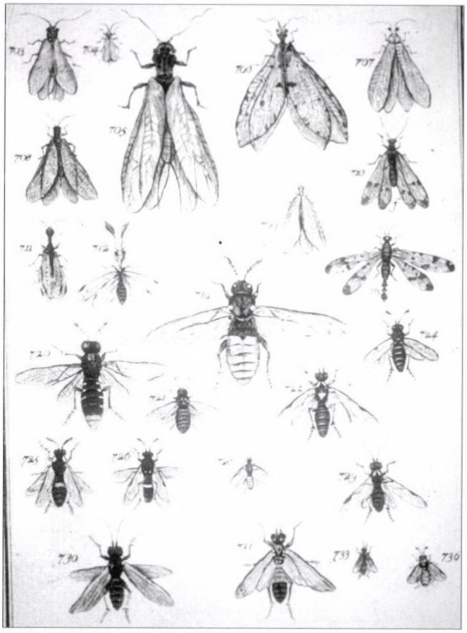
7


43 Kupfer

Entomologia Carniolica exhibens Insecta Carnioliae indigena et distributa in ordines, genera, species, varietates, methodo Linneana.

Vindobonae
1763

8



9

Figs 6–9. 6 = SCOPOLI (1763): Title page (Library H. & U. ASPÖCK); 7 = SCOPOLI (1763): Description of *Hemerobius fulvicephalus* (Library H. & U. ASPÖCK); 8 = SCOPOLI (1763): Handwritten title page of one of the few existing copies of the volume containing the illustrations (Library Naturhistorisches Museum Wien); 9 = SCOPOLI (1763): Plate with figures 703-736 (706 = *Hemerobius fulvicephalus*) (Library Naturhistorisches Museum Wien)

ILLUSTRATIONS UP TO 1820

After RÖSEL VON ROSENHOF (1755) and SCOPOLI (1763) and before 1820, illustrations of *Osmylus fulvicephalus* were published by SCHAEFFER (1769), SULZER (1776), HERBST and SOTZMANN (1786), ROEMER (1789), VILLERS (1789), DONOVAN (1797), OLIVIER (1797), WILHELM (1798, 1811), SHAW (1806), GERMAR (1817) and SAMOUELLE (1819) (Table 2).

These illustrations are of very different quality. RÖSEL VON ROSENHOF's figure is certainly one of the best, but the figures published by SULZER (1776) and, in particular, that of DONOVAN (1797) are also of a high standard, while those of HERBST and SOTZMANN (1786), OLIVIER (1797) and, particularly, of WILHELM (1798, 1811) and of GERMAR (1817) are incredibly poor. As in many other early illustrations of Neuropterida little attention was paid to correct drawings of the wing venation by many authors, particularly if other characters were sufficiently conspicuous to ensure recognition of the insects (ASPÖCK 1998, 1999).

DISCOVERY OF EARLY STAGES AND OF THE BIOLOGY

When RÖSEL VON ROSENHOF described the insect for the first time in 1755, he had no idea how it developed, and throughout almost the following hundred years the early stages and biology remained unknown. Some of the early authors mentioned association with moist habitats. SCOPOLI (1763) wrote "circa aquaeductus Fodinarum Idriensium, non rarus." DONOVAN (1797) stated "Like the ephemerae ... it delights in moist places particularly among weeds. The larva is un-

Table 2. Authors of publications with illustrations of Osmylidae (all representing *Osmylus fulvicephalus* SCOPOLI, 1763) before 1820. (In chronological order of the pertinent publications.)

AUGUST JOHANN RÖSEL VON ROSENHOF (1705–1759), German (of Austrian origin); 1755: Figs 1–5.
JOHANN ANTON SCOPOLI (1723–1788), Austrian; 1763: Figs 6–9.
JACOB CHRISTIAN SCHAEFFER (1718–1790), German; 1769: Figs 10–11.
JOHANN HEINRICH SULZER (1735–1813), Swiss; 1776: Figs 12–14.
JOHANN FRIEDRICH WILHELM HERBST (1743–1807), German, and D. F. SOTZMANN (?–?), German; 1786: Figs 15–17.
JOHANN JAKOB ROEMER (1761–1819), Swiss; 1789: Figs 18–20.
CHARLES JOSEPH DE VILLERS (1724–1810), Frenchman; 1789: Figs 21–23.
EDWARD DONOVAN (1768–1837), Englishman; 1797: Figs 24–26.
ANTOINE GUILLAUME OLIVIER (1756–1814), Frenchman; 1797: Figs 27–29.
GOTTLOB TOBIAS WILHELM (17..–1811), Austrian or German (Bavarian) ?; 1798: Figs 30–32.
GEORGE SHAW (1751–1813), Englishman; 1806: Figs 35–36.
ERNST FRIEDRICH GERMAR (1786–1853), German; 1817: Figs 37–38.
GEORGE SAMOUELLE (17..–1846), Englishman; 1819: Figs 39–40.

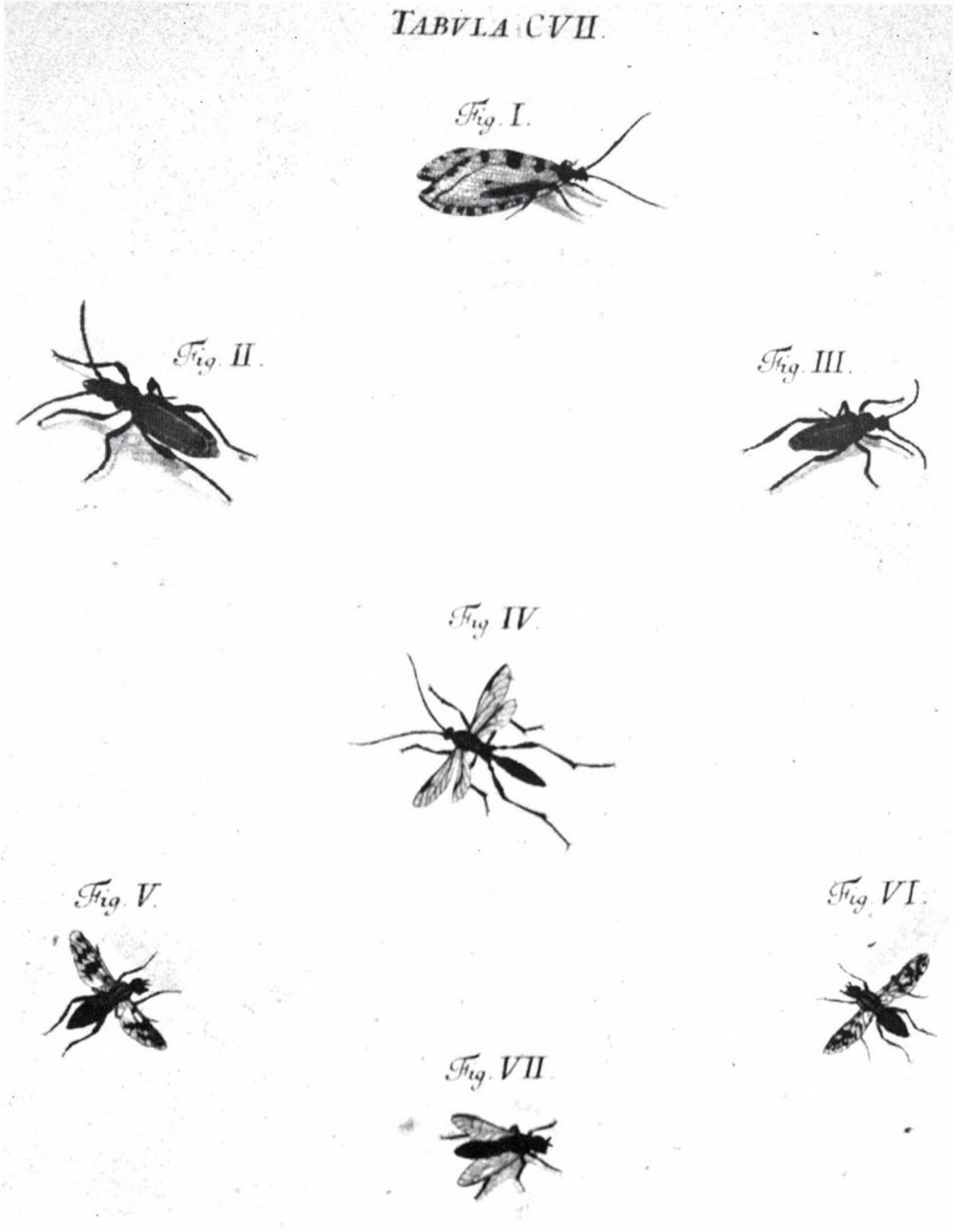
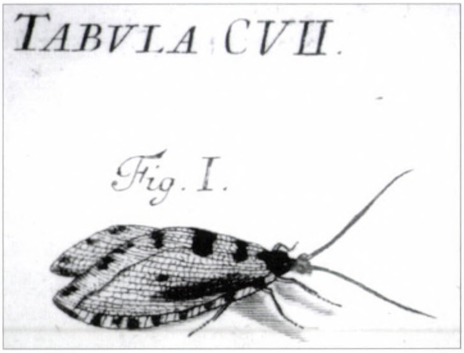


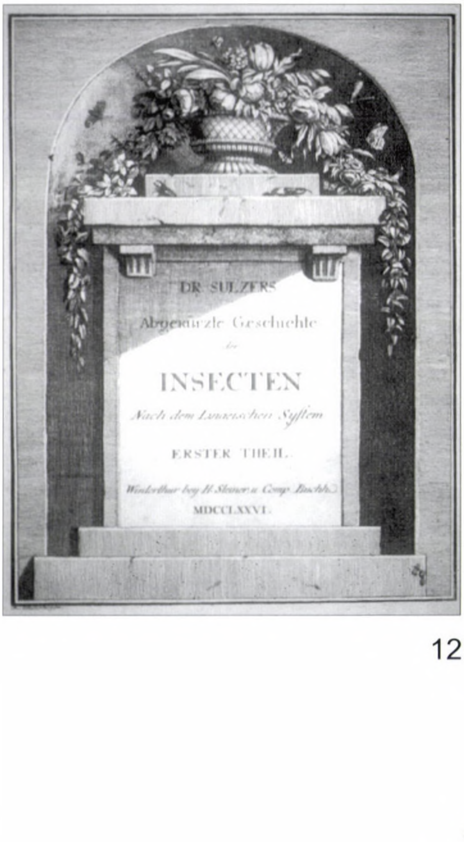
Fig. 10. SCHAEFFER (1769): Plate CVII. (Library H. & U. ASPÖCK)



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12



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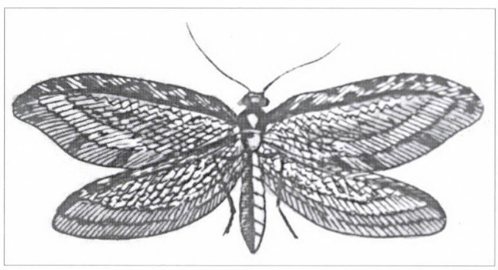
Figs 11–14. 11 = SCHAEFFER (1769): Detail of Plate CVII (Fig. 1) (Library H. & U. ASPÖCK); 12 = SULZER (1776): Title page (Library H. & U. ASPÖCK); 13 = SULZER (1776): Plate XXV. (Library H. & U. ASPÖCK); 14 = SULZER (1776): Detail of Plate XXV. (Library H. & U. ASPÖCK)



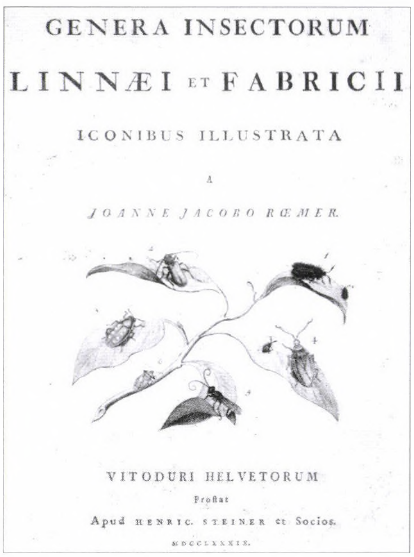
15



16



17


GENERA INSECTORUM

LINNÆI ET FABRICII

ICONIBUS ILLUSTRATA

A

JOANNE JACOBO RŒMER.

VITODURI HELVETORUM

Proſtat

Apud HENRIC. STEINER et Socios.

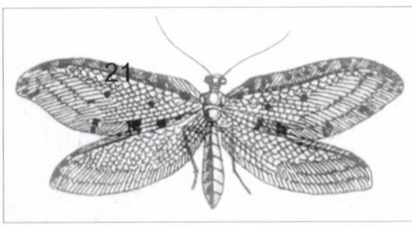
MDCCLXXXIX.

18

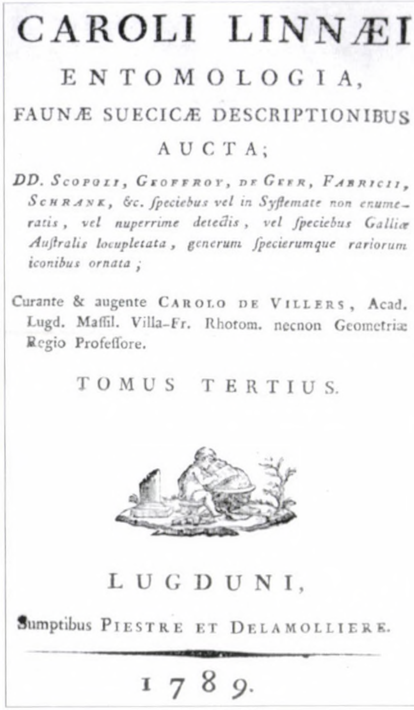
Figs 15–18. 15 = HERBST & SOTZMANN (1786): Title page (Library H. & U. ASPÖCK); 16 = HERBST & SOTZMANN (1786): Plate 320. (Library H. & U. ASPÖCK); 17 = HERBST & SOTZMANN (1786): Detail of Plate 320. (Library H. & U. ASPÖCK); 18 = ROEMER (1789): Title page (Library H. & U. ASPÖCK)



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20



CAROLI LINNÆI

ENTOMOLOGIA,

FAUNÆ SUECICÆ DESCRIPTIONIBUS

AUCTA;

DD. Scopolii, Geoffroy, de Geer, Fabricii, Schrank, &c. ſpeciebus vel in Syſtemate non enumeratis, vel nuperrime detectis, vel ſpeciebus Galliæ Auſtralis locupletata, generum ſpecierumque rariorum iconibus ornata;

Curante & augente Carolo de Villers, Acad. Lugd. Maſſil. Villa-Fr. Rhotom. necnon Geometriæ Regio Profeſſore.

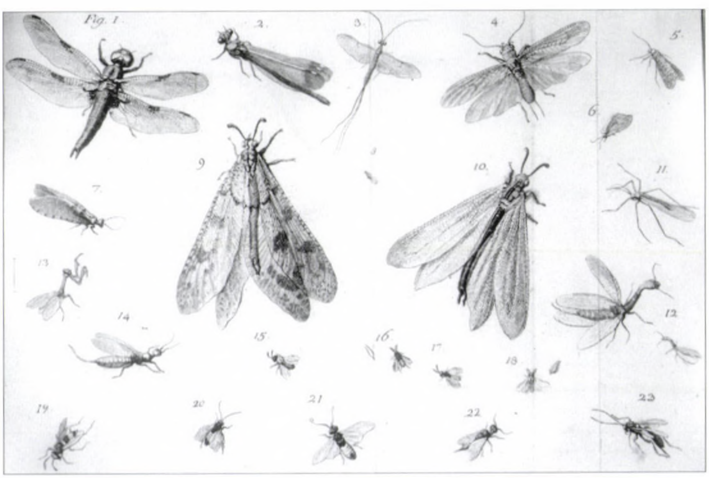
TOMUS TERTIUS.

LUGDUNI,

Sumptibus Piestre et Delamolliere.

1789.

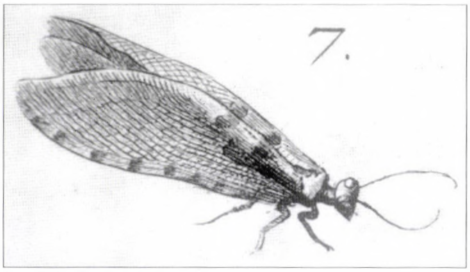
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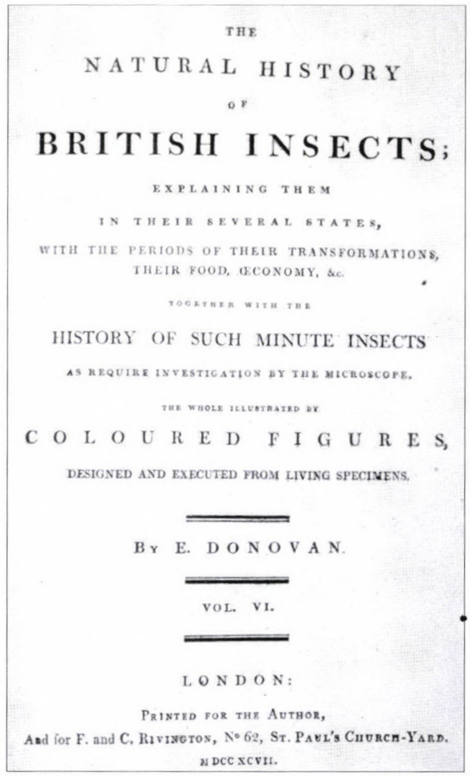
22

Figs 19–22. 19 = Roemer (1789): Plate XXV. (Library H. & U. Aspöck); 20 = Roemer (1789): Detail of Plate XXV. (Library H. & U. Aspöck); 21 = Villers (1789): Title page (Library H. & U. Aspöck); 22 = Villers (1789): Plate VII. (Library H. & U. Aspöck)

known, but is conceived to be of the aquatic kind." LATREILLE (1805) mentioned similarly "Ces insectes habitent plus particulièrement les lieux frais et humides" and STEPHENS (1836) wrote "…found in great abundance in some places, especially on the margins of a brook…". Shortly after that, STEIN (1838) found a pupa which yielded an *Osmylus*. He described the exuvia and stated that it had come



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THE
NATURAL HISTORY
OF
BRITISH INSECTS;
EXPLAINING THEM
IN THEIR SEVERAL STATES,
WITH THE PERIODS OF THEIR TRANSFORMATIONS,
THEIR FOOD, ŒCONOMY, &c.
TOGETHER WITH THE
HISTORY OF SUCH MINUTE INSECTS
AS REQUIRE INVESTIGATION BY THE MICROSCOPE.
THE WHOLE ILLUSTRATED BY
COLOURED FIGURES,
DESIGNED AND EXECUTED FROM LIVING SPECIMENS.

BY E. DONOVAN.

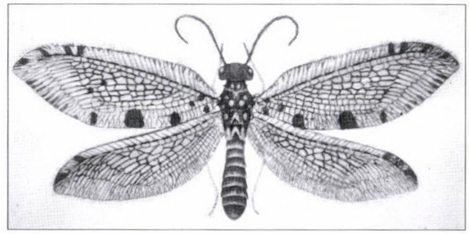
VOL. VI.

LONDON:
PRINTED FOR THE AUTHOR,
And for F. and C. RIVINGTON, N° 62, ST. PAUL'S CHURCH-YARD.
M DCC XCVII.

24



25



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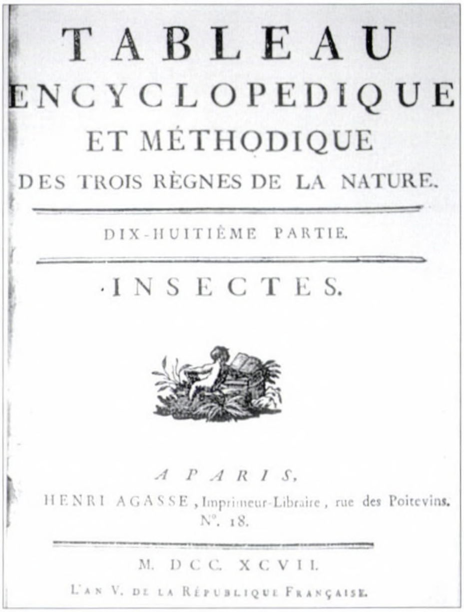
Figs 23–26. 23 = VILLERS (1789): Detail of Plate VII. (Library H. & U. ASPÖCK); 24 = DONOVAN (1797): Title page (Library H. & U. ASPÖCK); 25 = DONOVAN (1797): Plate 188 (Library H. & U. ASPÖCK); 26 = DONOVAN (1797): Detail of Plate 188 (Library H. & U. ASPÖCK)

from moist soil. ("Die Puppe lebt an Wassergräben, wahrscheinlich ...im feuchten Erdboden. Wenn sie sich verwandeln will, kriecht sie aus dem Gras hervor.")

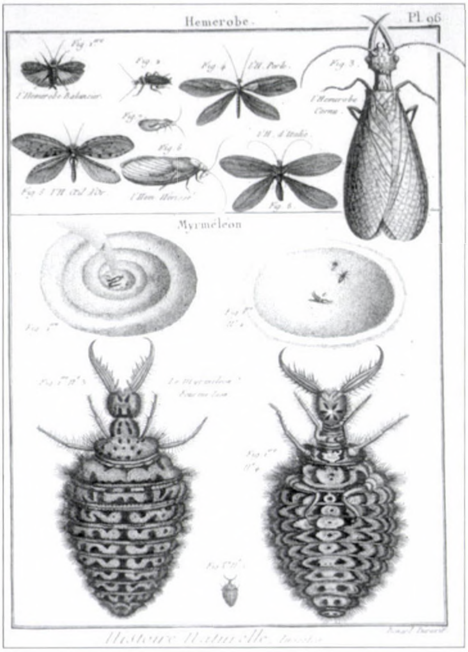
In 1839 H. C. BURMEISTER, author of the famous Handbook of Entomology and an authority of outstanding reputation, doubted that the larva lived in moist soil, but assumed that it was also a predator of aphids and similar to larvae of *Chrysopa*. In the same work BURMEISTER described the second known species of the family Osmylidae, *Osmylus strigatus* (now *Porismus strigatus*) from Australia, 84 years after RÖSEL VON ROSENHOF's first description and 76 years after SCOPOLI's first valid description of an osmylid.

In 1848 L. DUFOUR, author of an outstanding study of the morphology and anatomy of the adult stage of *Osmylus fulvicephalus*, wrote that the biology is absolutely unknown ("...on ignore completement ses metamorphoses, son genre de vie...").

At that time in Vienna, a boy named FRIEDRICH MORITZ BRAUER, born in 1832, grew up as a young enthusiastic entomologist. While still a teenager he began his studies on the biology of Neuroptera, and among these also on *Osmylus*. He found the larva at a brook near Grinzing (a village west of Vienna, today a part of

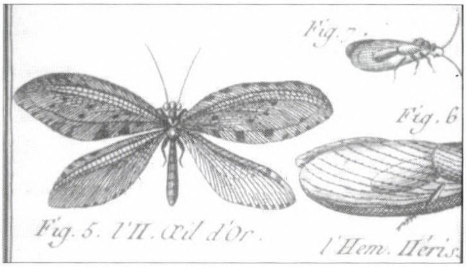

TABLEAU
ENCYCLOPEDIQUE
ET MÉTHODIQUE
DES TROIS RÈGNES DE LA NATURE.
DIX-HUITIÈME PARTIE.
·INSECTES.
A PARIS,
HENRI AGASSE, Imprimeur-Libraire, rue des Poitevins, N°. 18.
M. DCC. XCVII.
L'AN V. DE LA RÉPUBLIQUE FRANÇAISE.

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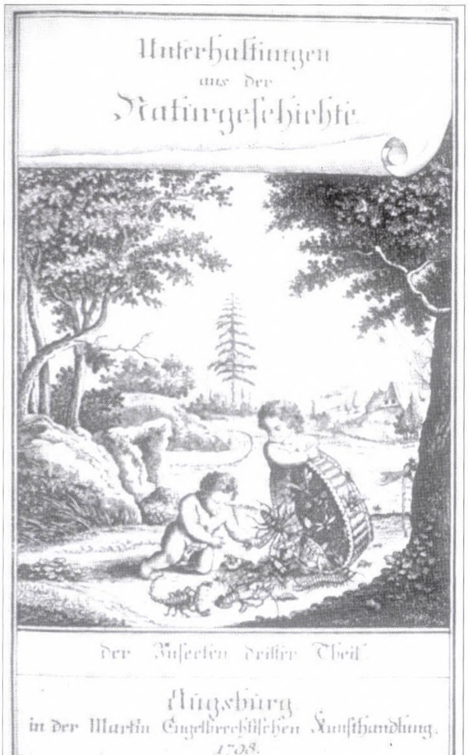
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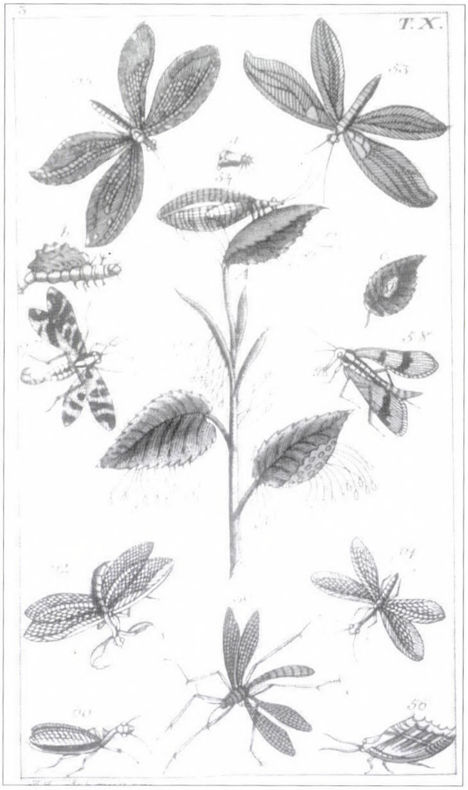
Figs 27–28. 27 = OLIVIER (1797): Title page (Library H. & U. ASPÖCK); 28 = OLIVIER (1797): Plate 96. (Library H. & U. ASPÖCK)



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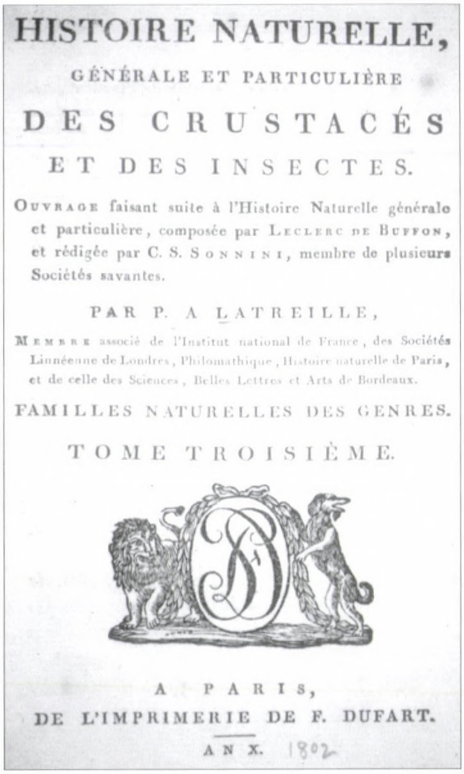
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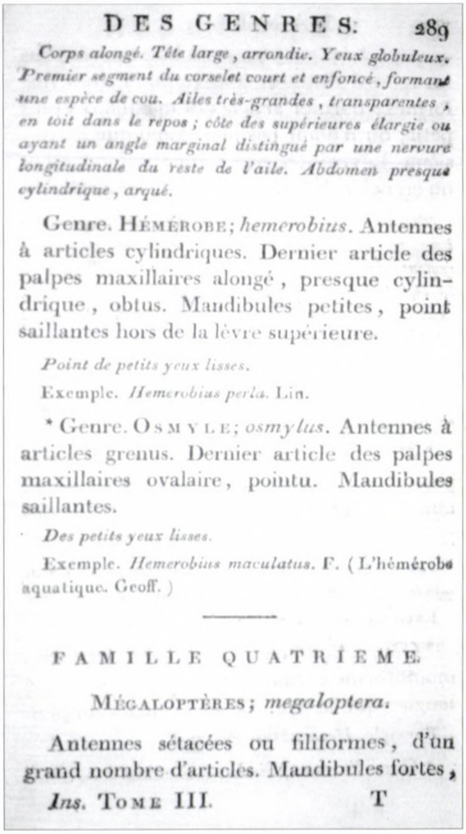
Figs 29–32. 29 = OLIVIER (1797): Detail of Plate 96. (Library H. & U. ASPÖCK); 30 = WILHELM (1798): Title page (Library H. & U. ASPÖCK); 31 = WILHELM (1798): Plate X. (Library H. & U. ASPÖCK); 32 = WILHELM (1798): Detail of Plate X. (Library H. & U. ASPÖCK)

the city) and studied the biology. As a pupil of 18 he presented his findings at a meeting of naturalists in Vienna and one year later, in 1851, he published his results (Figs 42–43). Stimulated by, and based upon BRAUER's findings, and with the help of living material sent from Vienna to Königsberg (now Kaliningrad) in Eastern Prussia (today Russia) HERMANN HAGEN carried out extensive and thorough studies on the life history and anatomy of *Osmylus*. He published a remarkable paper (HAGEN 1852), which is a masterpiece of observation and anatomy in entomology for the middle of the 19th century (Figs 44–45).



HISTOIRE NATURELLE,
GÉNÉRALE ET PARTICULIÈRE
DES CRUSTACÉS
ET DES INSECTES.
OUVRAGE faisant suite à l'Histoire Naturelle générale et particulière, composée par LECLERC DE BUFFON, et rédigée par C. S. SONNINI, membre de plusieurs Sociétés savantes.
PAR P. A LATREILLE,
MEMBRE associé de l'Institut national de France, des Sociétés Linnéenne de Londres, Philomathique, Histoire naturelle de Paris, et de celle des Sciences, Belles Lettres et Arts de Bordeaux.
FAMILLES NATURELLES DES GENRES.
TOME TROISIÈME.
A PARIS,
DE L'IMPRIMERIE DE F. DUFART.
AN X. 1802

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DES GENRES. 289

Corps alongé. Tête large, arrondie. Yeux globuleux. Premier segment du corselet court et enfoncé, formant une espèce de cou. Ailes très-grandes, transparentes, en toit dans le repos; côte des supérieures élargie ou ayant un angle marginal distingué par une nervure longitudinale du reste de l'aile. Abdomen presque cylindrique, arqué.

Genre. HÉMÉROBE; *hemerobius*. Antennes à articles cylindriques. Dernier article des palpes maxillaires alongé, presque cylindrique, obtus. Mandibules petites, point saillantes hors de la lèvre supérieure.

Point de petits yeux lisses.

Exemple. *Hemerobius perla*. Lin.

* Genre. OSMYLE; *osmylus*. Antennes à articles grenus. Dernier article des palpes maxillaires ovalaire, pointu. Mandibules saillantes.

Des petits yeux lisses.

Exemple. *Hemerobius maculatus*. F. (L'hémérobe aquatique. Geoff.)

FAMILLE QUATRIÈME.

MÉGALOPTÈRES; *megaloptera*.

Antennes sétacées ou filiformes, d'un grand nombre d'articles. Mandibules fortes,

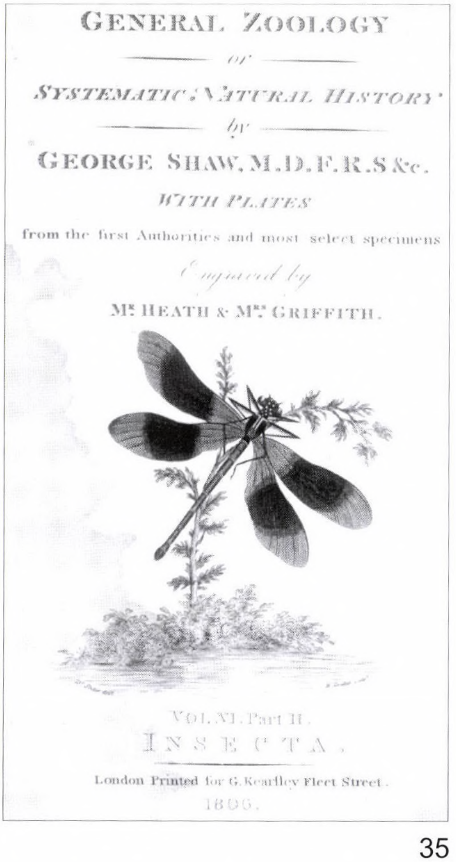
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Figs 33–34. 33 = LATREILLE (1802): Title page (Library H. & U. ASPÖCK); 34 = LATREILLE (1802): Description of *Osmylus* (Library H. & U. ASPÖCK)

OUTLOOK

When BRAUER and HAGEN published their findings, only two species of the family were known. Today we know about 160 described species assigned to 23 genera and 8 subfamilies. The distribution of the Osmylidae includes Europe, Asia, Africa, Australia and South America. It is possible that our planet harbours about 200 species of Osmylidae comprising a considerable biodiversity. The biology of most is entirely unknown – a large open field for future research.

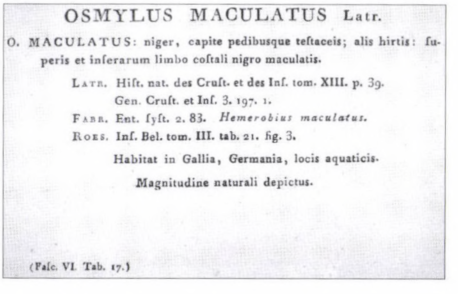

GENERAL ZOOLOGY
or
SYSTEMATIC NATURAL HISTORY
by
GEORGE SHAW, M.D. F.R.S &c.
WITH PLATES
from the first Authorities and most select specimens
Engraved by
Mr. HEATH & Mrs. GRIFFITH.
VOL. VI. Part II.
INSECTA.
London Printed for G. Kearsley Fleet Street.
1806.

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37


OSMYLUS MACULATUS Latr.

O. MACULATUS: niger, capite pedibusque teſtaceis; alis hirtis: ſuperis et inferarum limbo coſtali nigro maculatis.

LATR. Hiſt. nat. des Cruſt. et des Inſ. tom. XIII. p. 39.
Gen. Cruſt. et Inſ. 3. 197. 1.
FABR. Ent. ſyſt. 2. 83. *Hemerobius maculatus.*
ROES. Inſ. Bel. tom. III. tab. 21. fig. 3.

Habitat in Gallia, Germania, locis aquaticis.

Magnitudine naturali depictus.

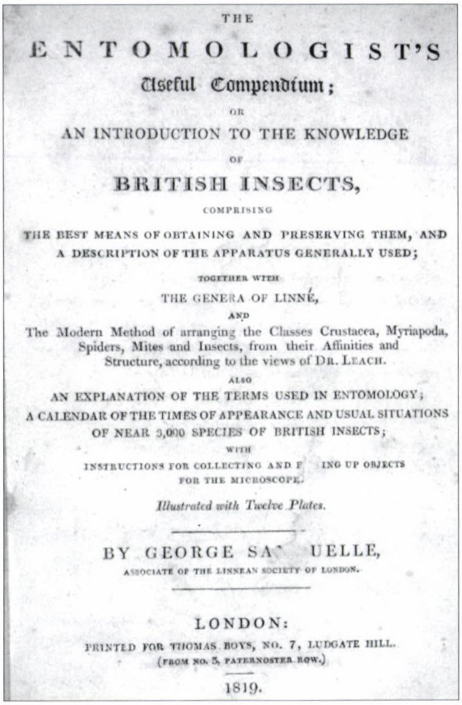
(Faſc. VI. Tab. 17.)

Figs 35–37. 35 = SHAW (1806): Title page (Library H. & U. ASPÖCK); 36 = SHAW (1806): Detail of Plate 83. (Library H. & U. ASPÖCK); 37 = GERMAR (1817): Text to Fasc. VI, Plate 17. (Library H. & U. ASPÖCK)



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THE

ENTOMOLOGIST'S

Useful Compendium;

OR

AN INTRODUCTION TO THE KNOWLEDGE

OF

BRITISH INSECTS,

COMPRISING

THE BEST MEANS OF OBTAINING AND PRESERVING THEM, AND A DESCRIPTION OF THE APPARATUS GENERALLY USED;

TOGETHER WITH

THE GENERA OF LINNÉ,

AND

The Modern Method of arranging the Classes Crustacea, Myriapoda, Spiders, Mites and Insects, from their Affinities and Structure, according to the views of DR. LEACH.

ALSO

AN EXPLANATION OF THE TERMS USED IN ENTOMOLOGY; A CALENDAR OF THE TIMES OF APPEARANCE AND USUAL SITUATIONS OF NEAR 3,000 SPECIES OF BRITISH INSECTS;

WITH

INSTRUCTIONS FOR COLLECTING AND F ING UP OBJECTS FOR THE MICROSCOPE.

Illustrated with Twelve Plates.

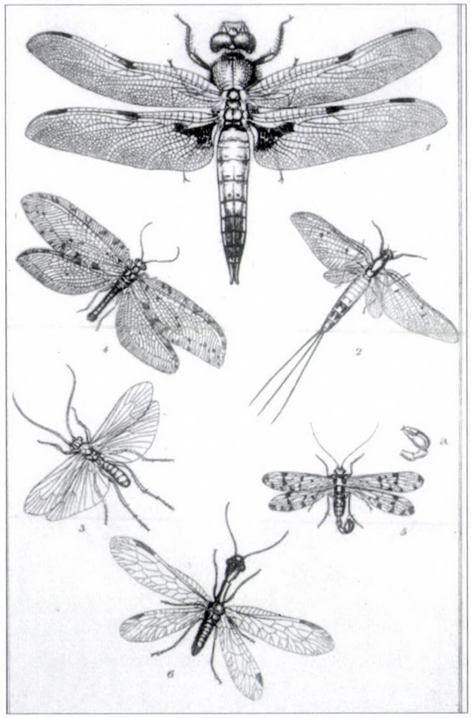
BY GEORGE SA UELLE,

ASSOCIATE OF THE LINNEAN SOCIETY OF LONDON.

LONDON:

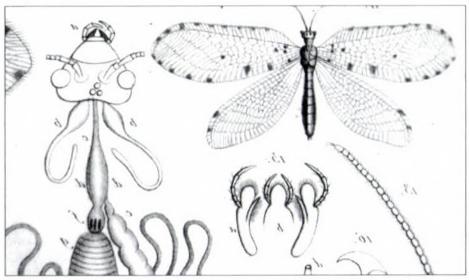
PRINTED FOR THOMAS BOYS, NO. 7, LUDGATE HILL. (FROM NO. 5, PATERNOSTER ROW.)

1819.

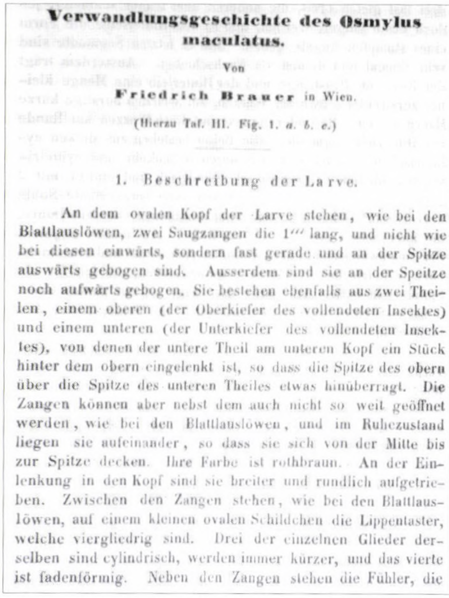


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Figs 38–41. 38 = GERMAR (1817): Plate 17 of Fasc. VI. (Library H. & U. ASPÖCK); 39 = SAMOUELLE (1819): Title page (Library H. & U. ASPÖCK); 40 = SAMOUELLE (1819): Plate 7. (Library H. & U. ASPÖCK); 41 = DUFOUR (1848): Detail of plate showing an imago of *Osmylus fulvicephalus* (Library Naturhistorisches Museum Wien)



Verwandlungsgeschichte des Osmylus maculatus.

Von

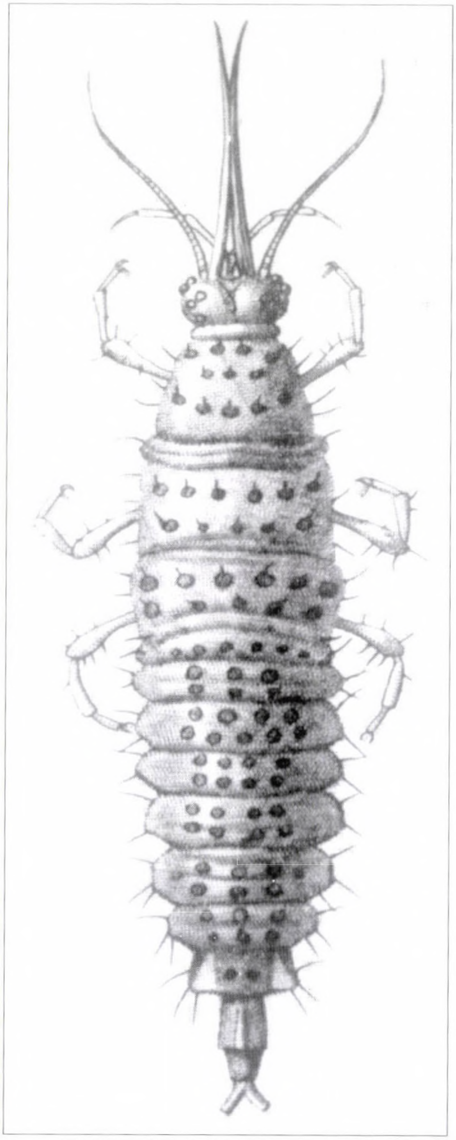
Friedrich Brauer in Wien.

(Hierzu Taf. III. Fig. 1. *a. b. c.*)

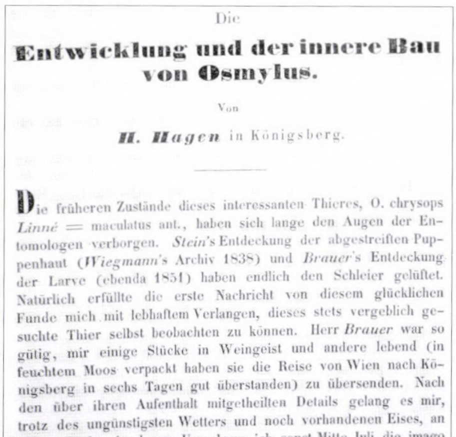
1. Beschreibung der Larve.

An dem ovalen Kopf der Larve stehen, wie bei den Blattlauslöwen, zwei Saugzangen die 1''' lang, und nicht wie bei diesen einwärts, sondern fast gerade und an der Spitze auswärts gebogen sind. Ausserdem sind sie an der Speitze noch aufwärts gebogen. Sie bestehen ebenfalls aus zwei Theilen, einem oberen (der Oberkiefer des vollendeten Insektes) und einem unteren (der Unterkiefer des vollendeten Insektes), von denen der untere Theil am unteren Kopf ein Stück hinter dem obern eingelenkt ist, so dass die Spitze des obern über die Spitze des unteren Theiles etwas hinüberragt. Die Zangen können aber nebst dem auch nicht so weit geöffnet werden, wie bei den Blattlauslöwen, und im Ruhezustand liegen sie aufeinander, so dass sie sich von der Mitte bis zur Spitze decken. Ihre Farbe ist rothbraun. An der Einlenkung in den Kopf sind sie breiter und rundlich aufgetrieben. Zwischen den Zangen stehen, wie bei den Blattlauslöwen, auf einem kleinen ovalen Schildchen die Lippentaster, welche viergliedrig sind. Drei der einzelnen Glieder derselben sind cylindrisch, werden immer kürzer, und das vierte ist fadenförmig. Neben den Zangen stehen die Fühler, die

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Die

Entwicklung und der innere Bau von Osmylus.

Von

H. Hagen in Königsberg.

Die früheren Zustände dieses interessanten Thieres, O. chrysops *Linné* = maculatus ant., haben sich lange den Augen der Entomologen verborgen. *Stein's* Entdeckung der abgestreiften Puppenhaut (*Wiegmann's* Archiv 1838) und *Brauer's* Entdeckung der Larve (ebenda 1851) haben endlich den Schleier gelüftet. Natürlich erfüllte die erste Nachricht von diesem glücklichen Funde mich mit lebhaftem Verlangen, dieses stets vergeblich gesuchte Thier selbst beobachten zu können. Herr *Brauer* war so gütig, mir einige Stücke in Weingeist und andere lebend (in feuchtem Moos verpackt haben sie die Reise von Wien nach Königsberg in sechs Tagen gut überstanden) zu übersenden. Nach den über ihren Aufenthalt mitgetheilten Details gelang es mir, trotz des ungünstigsten Wetters und noch vorhandenen Eises, an einem Bache, in dessen Umgebung ich sonst Mitte Juli die imago häufig gefangen hatte, den 22. April die Larve auch hier an einem Ellernstubben unter Moos sitzend anzutreffen. Allerdings war sie bedeutend kleiner als die vollständig ausgewachsenen Wiener Exemplare und sichtlich kaum aus dem Winterschlaf erwacht. Ein hiesiger Coleopterolog versichert, dass er schon früher in der nächsten Umgebung Königsbergs an ähnlichen Lokalitäten diese Larve nicht selten angetroffen habe. Ich habe übrigens später Mitte Mai ungeachtet der sorgfältigsten Nachsuchungen an jenen Orten weder Larve noch Puppe finden können und

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Figs 42–44. 42 = BRAUER (1851): First page (Library Naturhistorisches Museum Wien); 43 = BRAUER (1851): Detail of plate with the oldest illustration of the larva of *Osmylus fulvicephalus* (Library Naturhistorisches Museum Wien); 44 = HAGEN (1852): Title page (Library Naturhistorisches Museum Wien)

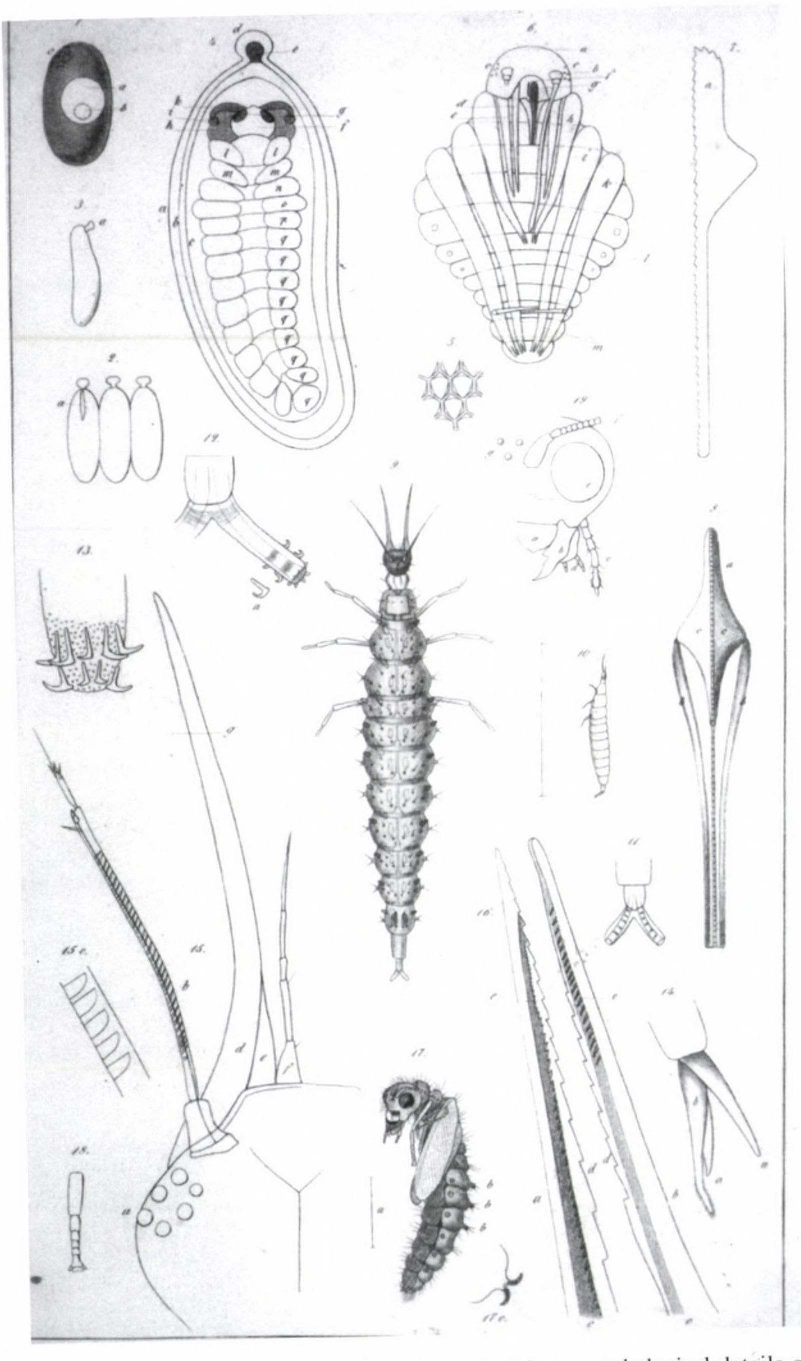


Fig. 45. HAGEN (1852): Plate with egg, larva, pupa and various morphological details of *Osmylus fulvicephalus* (Library Naturhistorisches Museum Wien)

*

Acknowledgement – I wish to express my grateful thanks to Prof. Dr. MERVYN MANSELL (Pretoria) and to Dr. TIM NEW (Bundoora, Victoria) for critical reading and improving the manuscript.

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THE BIOLOGY OF RAPHIDIOPTERA: A REVIEW OF PRESENT KNOWLEDGE

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Basic information on the systematics and distribution of the order Raphidioptera is provided, followed by details of the biology of snakeflies with respect to habitats, substrates upon which they develop, food of adults, food of larvae, life cycles, prothetely, mating and oviposition, parasites and parasitoids, hyperparasites, possible economic importance, and rearing methods.

Key words: Raphidioptera, biology, systematics, distribution, parasites, parasitoids, rearing methods

INTRODUCTION

Raphidioptera were among the most poorly investigated insects before 1960, and there was very little information on the biology of snakeflies. During the past 40 years, however, both families of the order – Raphidiidae and Inocelliidae – have been the subjects of intensive research in all major parts of the world where snakeflies occur. The number of known species has increased considerably, from 62 in 1960 to 206 species, which means that about 70% of the known species have been discovered within this period. Almost all of these have been studied alive, partly as adults but mainly as larvae in the field, and particularly in the laboratory during rearing of immature stages.

The aim of this review is to summarize what we know and what we do not know, and to outline open questions of particular significance, also in the context of a possible role of snakeflies in integrated pest control.

BASIC SYSTEMATIC FEATURES

The order Raphidioptera is a relic systematic group of "living fossils" (ASPÖCK 1998*b*, 2000), that comprises two extant families, Raphidiidae (with 185 described valid species) and Inocelliidae (with 21 species). The estimated total of extant snakeflies is about 260 species. The Raphidiidae are assigned to 25 recognised genera that comprise 7 (probably monophyletic) species groups* (group I, II,

* For the former group V see footnote to Table 1.

III, IV, VI, VII, VIII), while the Inocelliidae include 6 genera (ASPÖCK *et al.* 1991, 1998). A computerized cladistic analysis, including molecular biological data, is presently being carried out. The extant snakeflies are the remaining – and apparently far distant – twigs of many more branches of earlier geological periods: the Mesozoic biodiversity of the Raphidioptera was indeed much richer (ASPÖCK 1998, 2000).

DISTRIBUTION

Extant Raphidioptera are confined to the Northern Hemisphere and, moreover, almost exclusively to the Holarctic region. In Central America the southernmost records are from high altitudes at the Mexican–Guatemalan border. In Africa they have only been found in arboreal regions (*i.e.* in mountains) north of the Sahara, and in Asia the southernmost records are from altitudes above 900 m in transition areas from the Palaearctic to the Oriental Region in Northern India, Myanmar and Northern Thailand. It is of particular interest that the northern and eastern parts of North America lack snakeflies. Moreover, there is no genus or species with a Holarctic distribution, and almost all species are restricted to very limited areas of a refugial nature, sometimes even being restricted to a certain mountain range. Only three species manifest the Eurosiberian type of distribution throughout Northern Asia to Northern and Central Europe. A few species with Mediterranean distribution centres in Europe have expanded their distribution to extramediterranean parts of Europe, while a few species in North America with distribution centres in the southwest, succeeded in reaching the south of Canada after the last glacial period.

HABITATS

Snakeflies are confined to arboreal habitats, although in the broadest sense including all types of forests, macchias and even biotops with scattered shrubs. In the northern temperate zones they occur from sea level up to the timberline. In the warmer (temperate) zones (*e.g.* the Mediterranean, the Middle East, Central and Eastern Asia and Central America), they are confined to higher altitudes, occurring particularly between 1000 and 2000 m, but even reaching 3000 m in some parts.

In Europe they are typical inhabitants of coniferous as well as of deciduous forests, in Mediterranean regions a few species even occur above the treeline where there are only single bushes. In Central Asia they are characteristic insects of rocky slopes with single trees or shrubs (see illustrations in ASPÖCK *et al.* 1999)

and in Eastern Asia as well as in Central America they inhabit the pine forests in particular but also forests with decidous trees.

SUBSTRATES OF DEVELOPMENT

Since the first detection of a larva of a snakefly about 200 years ago by LATREILLE (ASPÖCK 1998*a*), and throughout the whole 19th and until the second half of the 20th century it was believed that larvae of Raphidioptera live exclusively under bark. The presence of a long ovipositor in all snakeflies, very suitable for laying eggs deeply under the bark, seemed to be a convincing confirmation of this assumption. We now know that all Inocelliidae, but only a part (probably even the smaller part) of Raphidiidae probably develop under bark. The majority of Raphidiidae have larvae that live in superficial layers of soil, particularly in the detritus around the roots of shrubs, possibly sometimes even in crevices of rocks (Table 1).

Table 1. Biology of Raphidioptera: development of larvae under bark (corticolous) or in superficial layers of soil/detritus at the base of shrubs, trees etc. (terricolous)

Family, genus-group, genus, subgenus	Number of species			
	corticolous	terricolous	corticolous and terricolous	unclarified
RAPHIDIIDAE				
Group I.				
Phaeostigma NAVÁS s. l.	13	13	9	6
Phaeostigma NAVÁS s. str.	6			
Graecoraphidia H. A. et U. A.			3	
Crassoraphidia H. A. et U. A.		1	2	
Magnoraphidia H. A. et U. A.	5			1
Pontoraphidia H. A. et U. A.		4		
Aegeoraphidia H. A., U. A. et R.		4	3	1
Caucasoraphidia H. A. et U. A.	2			
Superboraphidia H. A. et U. A.		3	1	1
Miroraphidia H. A. et U. A.		1		
Species not assigned to a subgenus				3
Dichrostigma NAVÁS		3		1
Tjederiraphidia H. A., U. A. et R.	1			

Table 1 (continued)

Family, genus-group, genus, subgenus	Number of species			
	corticolous	terricolous	corticolous and terricolous	unclarified
Turcoraphidia H. A. et U. A.		4		1
Iranoraphidia H. A. et U. A.				1
Tauroraphidia H. A., U. A. et R.	2			
Subilla NAVÁS	9			
Ornatoraphidia H. A. et U. A.		2		
Xanthostigma NAVÁS	1	1		3
Parvoraphidia H. A. et U. A.	3			
Ulrike H. A.				2
Raphidia L. s. l.	3	4	7	1
Raphidia L. s. str.	3	2	6	1
Aserbeidshanoraphidia H. A. et U. A.		1		
Nigroraphidia H. A. et U. A.		1	1	
Group II				
Atlantoraphidia H. A. et U. A.			1	
Harraphidia STEINMANN		2		
Hispanoraphidia H. A. et U. A.		1		
Africoraphidia U. A. et H. A.		1		
Ohmella H. A. & U. A.		4		
Italoraphidia H. A. et U. A.		1		
Puncha NAVÁS	1			
Group III				
Venustoraphidia H. A. et U. A.	2			
Mauroraphidia H. A., U. A. et R.	1			
Group IV				
Tadshikoraphidia H. A. et U. A.				2
Group VI*				
Mongoloraphidia H. A. et U. A. s. l.	9	16	1	29
Japanoraphidia H. A., U. A. et R.				1
Formosoraphidia H. A. et U. A.				3
Kirgisoraphidia H. A. et U. A.	2		1	
Mongoloraphidia H. A. et U. A. s. str.	3			9
Hissaroraphidia H. A., U. A. et R.				7
Ferganoraphidia H. A. et U. A.		1		

* Group V (*Usbekoraphidia*) has turned out to be a senior synonym of *Bureschiella* and is now (still) regarded as a subgenus of *Mongoloraphidia* (ASPÖCK *et al.* 1998).

Table 1 (continued)

Family, genus-group, genus, subgenus	Number of species			
	corticolous	terricolous	corticolous and terricolous	unclarified
Usbekoraphidia H. A. et U. A.	3			
Kasachoraphidia H. A. et U. A.				1
Neomartynoviella H. A. et U. A.		2		
Alatauoraphidia H. A. et U. A.		1		5
Species not asigned to a subgenus	1	12		3
Group VII				
Agulla NAVÁS, s. l.	4(?)	1(?)	1(?)	11
Agulla NAVÁS s. str.	4(?)	1(?)	1(?)	5
Glavia NAVÁS				4
Franciscoraphida H.A., U.A. et R.				1
Californoraphidia H. A., U. A. et R.				1
Group VIII				
Alena NAVÁS s. l.	3			5
Alena NAVÁS s. str.				1
Mexicoraphidia U. A. et H. A.	1			
Aztekoraphidia U. A. et H. A.	2			4
INOCELLIIDAE				
Fibla NAVÁS s. l.	4			
Fibla NAVÁS s. str.	3			
Reisserella H. A. et U. A.	1			
Parainocellia H. A. et U. A. s. l.	4			1
Parainocellia H. A. et U. A. s. str.	4			
Amurinocellia H. A. et U. A.				1
Inocellia SCHNEIDER	6			
Indianoinocellia U. A. et H. A.	2			
Negha NAVÁS	3(?)			
Sininocellia YANG				1
TOTAL	71	53	19	62

FOOD OF ADULTS

As far as we know, the adults of all species of Raphidiidae are entomophagous with a distinct preference for aphids and other Sternorrhycha. In captivity they may be fed with any arthropods, even strongly sclerotized species, if these are injured.

Adult snakeflies have repeatedly been observed to feed on pollen, and pollen is sometimes found in the gut when imagoes are dissected. Whether pollen is necessary, or whether it improves the condition (or prolongs the lifespan), is not known.

The natural food of Inocelliidae is virtually unknown. We have never observed any inocelliid feeding on an insect; however, this need not be necessarily conclusive. In captivity they take an artificial diet. Pollen has very rarely been found in the gut of adult inocelliids, but no special investigations have been carried out.

FOOD OF LARVAE

All stages of the larvae of all species of both families are entomophagous, feeding on a great variety of (preferably soft-bodied) arthropods. Virtually no special field studies have, however, been carried out to investigate the question of food under natural conditions. Potential prey may include eggs and larvae of any insects, particularly Lepidoptera, Hymenoptera, Coleoptera, larvae and adults of Psocoptera, Auchenorrhyncha and Sternorrhyncha, and also Collembola, mites and spiders (ASPÖCK *et al.* 1991, KOVARIK *et al.* 1991). It is suggested (but not really proven) that corticolous larvae may hunt for prey on the bark at night, which would be of great importance with respect to the selection of food. It is also not known how far they may move during the night (if they really migrate).

There is no doubt that the spectrum of prey must be considerably different in corticolous larvae on one hand and in larvae living in the soil on the other. Again, no field studies have been done. Under experimental conditions bark-dwelling and soil-dwelling larvae do not show any differences in their feeding behaviour.

LIFE CYCLES

During the past three decades several thousand larvae of a considerable number of species of Raphidioptera have been kept in captivity and largely reared to the adult stage. Many observations have consequently been recorded (ASPÖCK *et al.* 1974*a*, *b*, 1975, 1991, ASPÖCK *et al.* 1992, 1994*a*, *b*, 1995, KOVARIK *et al.* 1991, RAUSCH & ASPÖCK 1992, SUNTRUP 1990). The number of larval instars is not fixed, it varies around 10–11, but may reach 15 or even more (ASPÖCK *et al.* 1991, KOVARIK *et al.* 1991).

The egg stage lasts, probably in all species without exception, a few days up to three weeks only.

The larval period lasts at least (in few species of Raphidiidae of group I and of *Agulla*) one year, in most species two or three years and, at least under experimental conditions, in some individuals of some species several (up to six) years. The prepupal stage is always a short period of a few days duration only.

The duration of the pupal stage depends on the time of pupation. In the majority (most genera of group I except *Tjederiraphidia* and *Ornatoraphidia*; genera of groups III, IV, and VII; most Inocelliidae) pupation (usually) takes place in spring and lasts a few days up to about three weeks (life cycle type I).

In some (or all) species of a few genera of Raphidiidae (life cycle type II: *Tjederiraphidia, Ornatoraphidia, Atlantoraphidia, Harraphidia, Hispanoraphidia, Africoraphidia, Ohmella*) pupation (usually) takes place in summer or autumn, and the pupal stage lasts several (up to 10!) months. In very few species (genus *Alena*, Mexican inocelliid species) pupation takes place in summer and after a pupal stage of a few weeks the adults hatch in late summer (life cycle type III).

Hibernating stages may thus be the last larval stage (usually type I), penultimate (or even an earlier) larval stage (type III, rarely probably also in type I) or pupa (type II), but never egg, prepupa or adult. Figure 1 shows the three main types of life cycles known in Raphidioptera.

It is of interest that single individuals of species belonging to type II may sometimes behave like species of type I, *i.e.* they pupate after hibernation of the last larval stage.

As far as we know all snakeflies need a period of low temperature (probably around 0°C) to induce pupation (type I) or hatching of the imago (type II). In type III the low temperature is probably important for the mature larvae to pupate in (late) summer after one or two moults after winter. KOVARIK *et al.* (1991), who studied the American snakefly *Agulla bicolor* (type I) stated that "chilling was not necessary to initiate pupation". This finding needs further confirmation, and it will have to be determined whether this can be reproduced in a larger number of specimens. It is possible that in some species only a slight decrease of temperature may be sufficient.

PROTHETELY

Larvae that are continuously kept at room temperature will usually not pupate, but may live several years with several additional moults thus reaching up to 15 instars. Most of these larvae become prothetelous, *i.e.* they develop pupal or imaginal characters, *e.g.* compound eyes, wing pads, and appendages on the abdo-

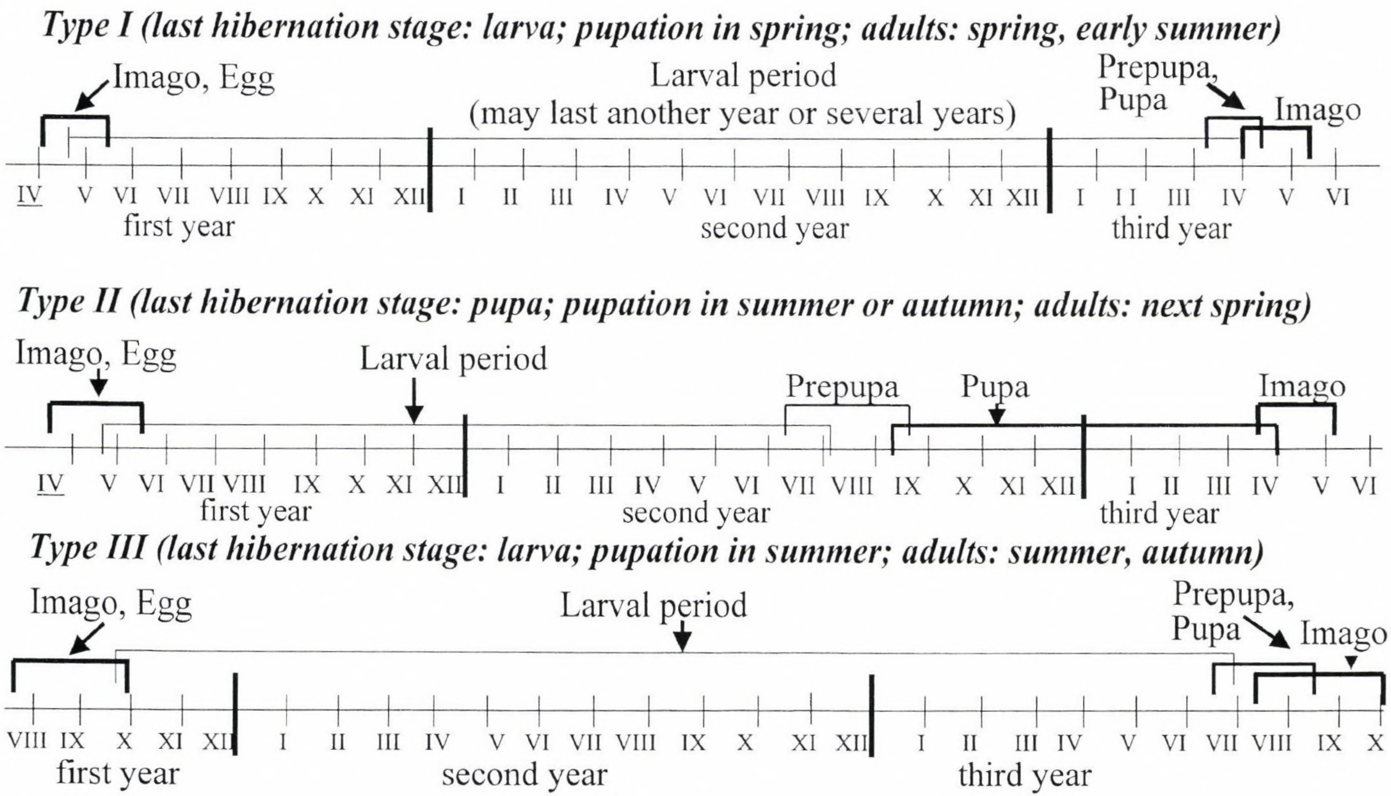


Fig. 1. Life cycles of Raphidioptera

men. The prothetelous larvae may live for further months, even years, but eventually, they usually die. Pupation may be achieved only in very rare cases, and in even rarer cases an adult will hatch with various abnormalities.

MATING AND OVIPOSITION

Courtship behaviour and mating have been repeatedly observed and described (ASPÖCK *et al.* 1991, KOVARIK *et al.* 1991, ASPÖCK *et al.*1995). Two positions of copulation have been found; a "wrecking position", in which the male hangs head first from the female and being carried by her, and a "tandem position", in which the male crawls under the female attaching his head in fixed connection to the fifth sternite of the female. The "wrecking position" is the usual position found in all Raphidiidae examined (with some differences in *Alena*). The "tandem position" has been observed in Inocelliidae only and is probably typical for the whole family. So far it has not been revealed how the male fixes his head to the ventral side of the female. There are eversible sacs near the bases of the antennae and these are apparently (how?) attached to the fifth sternite of the female.

Copulation lasts a few minutes to 1½ hours in Raphidiidae, but is much longer, up to three hours in Inocelliidae.

PARASITES AND PARASITOIDS

Table 2 provides a list of the species known to parasitise Raphidioptera.

The Gregarinida are apparently non-pathogenic. Mermithids usually kill their hosts, but they are extremely rare in snakeflies. Erythraeid mites are sometimes found on adults, but are not life-threatening and, moreover, rare.

Hymenoptera are of considerable significance as parasitoids of larvae. Species of genus *Nemeritis* (Ichneumonidae) of the subfamily Campopleginae are by far the most important parasitoids. They probably comprise 90–95% of all parasitoids in snakefly larvae, at least in the Palaearctic. Two species are particularly frequent in Western Palaearctic Raphidioptera: *Nemeritis caudatula* and *N. specularis*. Both species are widely distributed from Morocco and Spain in the west throughout Europe to Eastern Anatolia. Both have been found in many species of both families, Raphidiidae as well as Inocelliidae, and they comprise 70–80% of all parasitised larvae.

Other ichneumonids, braconids and chalcidids contribute to about 1% of the parasitised larvae. In the Palaearctic 5–15% of a population are usually parasitised,

Table 2. Parasites (P) and parasitoids (Pd) in Raphidioptera (R = Raphidiidae, I = Inocelliidae). See also ASPÖCK *et al.* (1991), HORSTMANN (1993, 1994), SUNTRUP (1990)

Parasite (P), parasitoid (Pd)	Raphidiopteran hosts recorded	Parasitised stage	Other hosts
Protozoa: Apicomplexa: Eugregarinida Gregarinidae			
P *Gregarina raphidiae* ACHTELIG	R: *Phaeostigma* s.l. (2 spp.)	Larva	–
	Raphidia s.str. (1 sp.)	Larva	
Nematoda: Trichosyringida			
Mermithoidea: Mermithidae			
P Mermithidae gen. sp.	I: *Fibla* (1 sp.)	Larva	?
Acari: Trombidiformes: Erythraeidae			
P Erythraeidae gen. sp.	R: *Xanthostigma* (1 sp.)	Imago	?
Hymenoptera:			
Ichneumonidae: Campopleginae			
Pd *Nemeritis caudatula* THOMSON	R: *Phaeostigma* s.l. (10 spp.)	Larva	–
	Subilla (3 spp.)	Larva	
	Xanthostigma (1 sp.)	Larva	
	Raphidia s.str. (2 sp.)	Larva	
	Puncha (1 sp.)	Larva	
	Venustoraphidia (1 sp.)	Larva	
	Mauroraphidia (1 sp.)	Larva	
	I: *Fibla* s.str. (3 spp.)	Larva	
	Parainocellia (1 sp.)	Larva	
Pd *Nemeritis scaposa* HORSTMANN	R: *Raphidia* s.l. (5 spp.)	Larva	–
Pd *Nemeritis specularis specularis* HORSTMANN	R: *Phaeostigma* s.l. (11 spp.)	Larva	–
	Tauroraphidia (2 spp.)	Larva	
	Subilla (5 spp.)	Larva	
	Ornatoraphidia (1 sp)	Larva	
	Raphida s.str. (1 sp.)	Larva	
	Puncha (1 sp.)	Larva	
	Venustoraphidia (1 sp.)	Larva	
	I: *Fibla* (1 sp.)	Larva	
	Parainocellia s.str. (2 spp.)	Larva	
Pd *Nemeritis specularis anatolica* HORSTMANN	R: *Phaeostigma* s.l. (4 spp.)	Larva	–
	Tauroraphidia (1 sp.)	Larva	

Table 2 (continued)

Parasite (P), parasitoid (Pd)		Raphidiopteran hosts recorded	Parasitised stage	Other hosts
Pd	*Nemeritis specularis anatolica* HORSTMANN	*Raphidia* s.l. (3 spp.)	Larva	
Pd	*Nemeritis specularis indica* HORSTMANN	I: *Inocellia* (1 sp.)	Larva	–
Pd	*Nemeritis elegans* (SZÉPLIGETI)	R: *Dichrostigma* (1 sp.)	Larva	–
Pd	*Nemeritis colossea* HORSTMANN	R: *Subilla* (1 sp.)	Larva	–
Pd	*Nemeritis silvicola* HORSTMANN	R: *Phaeostigma* s.l. (2 spp.)	Larva	–
Pd	*Nemeritis* sp. B (near *silvicola* and *graeca*)	R: Raphidiidae gen.sp. (1 sp.)	Larva	–
Pd	*Nemeritis canaliculata* HORSTMANN	R: *Phaeostigma* s.l. (1 sp.)	Larva	–
Pd	*Nemeritis* sp. C (near *canaliculata*)	R: *Phaeostigma* (1 sp.)	Larva	–
Pd	*Nemeritis graeca* HORSTMANN	R: *Phaeostigma* s.l. (3 spp.)	Larva	–
Pd	*Nemeritis similis* HORSTMANN	R: *Phaeostigma* s.l. (3 spp.)	Larva	–
		Raphidia s.str. (1 sp.)	Larva	–
Pd	*Nemeritis* sp. D (near *similis*)	R: *Phaeostigma* s.l. (1 sp.)	Larva	–
Pd	*Nemeritis* sp. E (near *similis*)	R: *Phaeostigma* s.l. (2 spp.)	Larva	–
Pd	*Nemeritis* sp. F	R: *Subilla* (1 sp.)	Larva	–
Ichneumonidae: Cryptinae				
Pd	*Tropistes falcatus* (THOMSON)	R: *Phaeostigma* (1 sp.)	Larva	?
		Puncha (1 sp.)	Larva	
Pd	*Tropistes nitidipennis* (GRAVENHORST)	R: *Puncha* (1 sp.)	Larva	?
Ichneumonidae: Pimplinae				
Pd	*Itoplectis alternans* (GRAVENHORST)	Raphidiidae gen. sp	Larva	Broad host spectrum comprising Lep., Col., Dipt. & Hym.
Hymenoptera: Braconidae: Euphorinae				
Pd	*Meteorus pachypus* (SCHMIEDEKNECHT)	R: *Xanthostigma* (1 sp.)	Larva	?
Pd	*Meteorus punctifrons* THOMSON	R: *Hispanoraphidia* (1 sp.)	Larva	?
Hymenoptera: Chalcidiodea: Perilampidae				
Pd	*Perilampus maceki* BOUČEK	I: *Inocellia* sp	Larva	?

Table 3. Hyperparasites in Raphidioptera

Hyperparasite	Raphidiopteran hosts (larvae) parasitized by Ichneumonidae	Other hosts
Hymenoptera: Chalcidoidea: Perilampidae		
Perilampus polypori BOUČEK	Raphidiidae:	?
	Phaeostigma s.l. (6 spp.)	
	Subilla (2 spp.)	
	Puncha (1 sp.)	
	Venustoraphidia (1 sp.)	
	Inocelliidae:	
	Parainocellia s.str. (1 sp.)	
Perilampus cephalotes BOUČEK	Raphidiidae:	?
	Phaeostigma s.l. or	
	Raphidia s.str. (1 sp.)	
	Puncha (1 sp.)	

but in a few populations more than 50% of the larvae of a species were parasitised. It is, however, of interest that among some hundred larvae of several species collected in Mexico (under bark of pines) none was found to be parasitised.

Hyperparasites so far recorded (only Chalcidoidea: Perilampidae) are listed in Table 3.

ECONOMIC IMPORTANCE

Snakeflies are effective predators. All larval stages of all species of both families, and at least the adults of the Raphidiidae feed on (mainly soft-bodied) arthropods (see above) so that the question arises as to whether they could play a significant role in integrated pest control.

Three basic facts should be considered (ASPÖCK 1991, ASPÖCK *et al.* 1991):

1. Because of historical/zoogeographical but not for ecological factors, large parts of our planet lack snakeflies: including the north and east of North America and the whole southern hemisphere. Within this huge area there are large regions with ecologically very favourable conditions for Raphidioptera.

2. This means that an introduction of Raphidioptera into these areas could be promising, particularly in reforestation areas and in fruit plantations.

3. On the other hand, manipulations within the natural distribution area are most probably of no use.

Snakeflies are believed to be rare insects. This is indeed true for many species and many regions, but it is not correct for a number of species that often occur in large numbers.

Here is an overview of arguments for and against effective use of snakeflies in integrated pest control:

ADVANTAGES

- Rearing techniques as a basic prerequisite are well-established.
- Introduction of parasite-free populations would consequently be possible.
- Biology of many potential species is very well-known.
- Larvae (and adults of at least of Raphidiidae) are predacious.
- Long larval period.
- Polyphagy?
- Snakeflies do not have important specific natural enemies.

DISADVANTAGES

- Long developmental period.
- Polyphagy?
- Due to long life-cycles only slow change of population densities, which means slow and delayed adaptation to altered conditions.
- High stenotopy and therefore slow disperse.
- Association with certain plants (trees) weak.

No substatial experimental data available.

As early as 100 years ago there were several attempts to use snakeflies as biological control agents in pest management. One or two unidentified North American species were introduced into Australia and New Zealand, but apparently they could not be established. At that time, however, nobody knew that low temperatures at a certain period in the development are necessary. And at that time it was also impossible to rear snakeflies.

Today we are in a much better position. During the past thirty years we have gathered much experience in general, and a large amount of substantial data in particular which have enabled us to standardise the rearing of snakeflies.

REARING METHODS

Rearing usually commences with a female collected in the field. For oviposition we use plastic vials of about 25 mm diameter and 40 mm in length with a densely packed roll of cellulose. A damaged fly (or any squashed insect) or a few aphids provide adequate food, and the female will readily start laying eggs between the

layers of the cellulose. The eggs are usually fertile, as a female taken in the field has usually already copulated. After a few days the larvae hatch and will spread into the various parts of the cellulose. This prevents them from eating each other, particularly if a few immobilised *Drosophila* adults are added. These serve as a source of food as well as providing humidity. The larvae may be kept in this first vial for a few months, then they should be separated as they become an increasing danger to one another. The same vials can be used for the separated larvae. Mealworms cut into pieces are an excellent food, but other (soft-bodied) insects (e.g. *Drosophila*) should occasionally be added. Food should be changed every 4–8 weeks. It is essential that the larvae are transferred to low temperatures in autumn and kept at low temperature for some time. It is not yet known how long and which temperatures are necessary – possibly exposure to low temperature (perhaps in many species only around 0°C) for a few days – will be sufficient for standardisation. As long as we do not know the answer to this question, we keep them at low temperatures for at least four months. In early spring they should be transferred to room temperature again and be kept in the vials as described. For the second hibernation of the larva or for hibernation of pupae the same procedure is necessary. Usually (type I), after two or three hibernations, the larvae will pupate and the pupae will develop to adults within ten to twenty days. Mating is necessary for a continuation of the culture, and this is certainly the most laborious part, mainly due to the long and complicated mating ritual. Nevertheless we have repeatedly successfully induced copulation of snakeflies in captivity. Some species copulate readily even in small vials, other need branches in larger cages for their mating ritual. As soon as copulation has been completed, females may be placed in vials for oviposition and the procedure can be repeated as described above.

These methods of rearing Raphidioptera have been an indispensable prerequisite for clarifying both taxonomy of larvae and biology of many snakeflies. They will, however, also be helpful to clarify a number of unanswered questions. There are several species of which the larvae are still unknown. And there are some important questions concerning the biology of snakeflies that have not yet been resolved. One of the most urgent is the question of factors that induce or which prevent prothetely, *i.e.* which temperatures are essential at particular stages of development, and are there other factors?

OUTLOOK

In summary, there are still many open questions concerning the biology of Raphidioptera. There is, however, an excellent basis with respect to the taxonomy

on one hand and established field and laboratory methods on the other, so that essential progress of our knowledge may be expected in the near future.

*

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HOMOLOGY OF MALE GENITAL SCLERITES IN NEUROPTERIDA – AN ADVENTURE*

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Interpretation of male genital sclerites of Neuropterida has always been fraught with ambiguity. Previous controversial approaches may be summarised by the slogan: archaic derivatives versus derived novelties. Arguments for homologizing via a gonocoxite concept are presented here. The primitive machilid (Archaeognatha, Machilidae) structures provide the background for identifiying the amazingly similar male genital sclerites of Raphidioptera. The comparatively complete segment 9 of Raphidioptera consists of tergite, sternite, large gonocoxites, styli and gonapophyses; it serves as a reference model for our understanding of segment 10 and 11 in Raphidioptera and of male genital sclerites in Megaloptera and Neuroptera. The large machilid / raphidiopteran gonocoxites 9 changed to appendage-like sclerites in Megaloptera and Neuroptera, and even shifted into the genital chamber in some neuropteran taxa, or became obliterated. The styli of segment 9 have been lost independently several times. Gonapophyses 9 remained rod-like or evolved substantially in Raphidiidae (hypovalva), but were lost in Megaloptera and in most Neuroptera. Sclerites of segment 10 underwent the most dramatic changes, and obliterations reflected in requirements for copulation: only the tergite remained, but amalgamated with tergite 11, forming the ectoproct. All other sclerites shifted into the genital chamber. Gonocoxites 10 apparently became lost, although their gonapophyses persist as parameres (*e.g.* in *Phaeostigma* Navás and *Italochrysa* Principi). The mediuncus (penis) is interpreted as the fused styli of the otherwise lost gonocoxites. Sclerites of segment 11 are still traceable: the tergite (amalgamated in the ectoproct), and the sternite, possibly as a tiny subanale. The gonarcus is interpreted as the gonocoxites 11, the entoprocessus as the corresponding gonapophyses, and the arcessus as the fused styli of gonocoxites 11. The hypandrium internum, irrespective of its true nature (which still remains doubtful), may indeed be a peculiarity of the Neuropterida – although most likely lacking in Megaloptera.

* Unchanged abstract of the lecture presented by the author. A comprehensive paper entitled "Male genital sclerites of Neuropterida: an attempt at homologisation (Insecta: Holometabola)" will be published in *Zool. Anz.* 241 (2002): 161–171.

The Fauna of the Aggtelek National Park

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edited by S. MAHUNKA and L. ZOMBORI

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THE GREEN LACEWINGS IN BELGIUM (NEUROPTERA: CHRYSOPIDAE)

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There are merely three published sources of information on the green lacewings in Belgium. The first two were written by a Belgian and a Catalan author at the beginning of the 20th century and the third was published in 1980. Interestingly, the most recent study reported the fewest species (11), the most previous contained 12 and the second one showed 17 species. This confused situation and the paucity of data initiated the authors to identify the green lacewing collection of the Gembloux University of Agricultural Sciences, where lacewings from different parts of Belgium were preserved, and also to collect chrysopids regularly. Summarising the species reported in the literature and caught during sampling, 18 green lacewing species have been verified in Belgium: *Nothochrysa fulviceps, Nothochrysa capitata, Hypochrysa elegans, Nineta flava, Nineta vittata, Nineta pallida, Chrysotropia ciliata, Chrysopa perla, Chrysopa dorsalis, Chrysopa abbreviata, Chrysopa formosa, Chrysopa phyllochroma, Chrysopa pallens, Dichochrysa flavifrons, Dichochrysa prasina, Dichochrysa ventralis, Chrysoperla carnea, Cunctochrysa albolineata.* Considering the known references, one species, *Nineta pallida* proved to be new for the Belgian fauna.

Key words: Chrysopidae, Belgium

INTRODUCTION

Information on green lacewings of Belgium is quite scarce. One can find only three sources of data of which the first two at the beginning of the 20th century were written by a Belgian (LAMEERE 1900) and a Catalan author (NAVÁS 1913). Unfortunately no more Belgian contribution has been published on this subject. The third source is the well-known work of ASPÖCK *et al.* (1980). Although it is the most recent study referring to Belgian aspects of Chrysopidae, it reported the fewest (11) species: *Nothochrysa fulviceps* (STEPHENS, 1836), *Nothochrysa capitata* (FABRICIUS, 1793), *Nineta vittata* (WESMAEL, 1841), *Chrysotropia ciliata* (WESMAEL, 1841), *Chrysopa dorsalis* BURMEISTER, 1839, *Chrysopa abbreviata* CURTIS, 1834, *Chrysopa formosa* BRAUER, 1850, *Anisochrysa (=Dichochrysa) flavifrons* (BRAUER, 1850), *Anisochrysa (=Dichochrysa) prasina* (BURMEISTER, 1839), *Anisochrysa (=Dichochrysa) ventralis* (CURTIS, 1834), *Chrysoperla carnea* (STEPHENS, 1836) [*Chrysoperla carnea* is meant in this paper as *Chrysoperla*

carnea sensu lato]). The earliest (LAMEERE 1900) recounted 12 (*Nothochrysa fulviceps, Nothochrysa capitata, Chrysopa (= Nineta) vittata* WESMAEL, 1841, *Chrysopa (= Nineta) flava* SCOPOLI: HÖLZEL 1965, *Chrysopa alba* (LINNAEUS): STEPHENS 1836 *(=Chrysotropia ciliata), Chrysopa septempunctata* WESMAEL, 1841 (*=pallens* (RAMBUR, 1838)), *Ch. abbreviata, Chrysopa phyllochroma* WESMAEL, 1841, *Chrysopa (= Dichochrysa) flavifrons* BRAUER, 1850, *Chrysopa (=Dichochrysa) ventralis* CURTIS, 1834, *Chrysopa perla* (LINNAEUS, 1758), *Chrysopa vulgaris* SCHNEIDER, 1851 (*=Chrysoperla carnea*)) and NAVÁS (1913) pointed out 17 species (*Nothochrysa fulviceps, Nothochrysa capitata, Hypochrysa nobilis* HEYDEN (sic!) (*=elegans* BURMEISTER, 1839), *Nineta vittata, Nineta flava* (SCOPOLI, 1763), *Ch. alba, Ch. septempunctata, Ch. abbreviata, Ch. phyllochroma, Ch. flavifrons, Chrysopa (=Dichochrysa) prasina* BURMEISTER, 1839, *Ch. ventralis, Ch. perla, Ch. formosa, Ch. dorsalis, Ch. vulgaris, Chrysopa tenella* SCHNEIDER, 1851 (*=Cunctochrysa albolineata* (KILLINGTON, 1935)). Besides the aforementioned published material MAGIS (1980, unpubl.) identified nine species: *Ch. carnea, Ch. perla, Ch. pallens, Ch. phyllochroma, Ch. ventralis, Chrysotropia ciliata, D. flavifrons, D. prasina, Nineta flava* and SÉMÉRIA (1981, unpubl.) one taxon, *Nineta vittata*.

This bewildering situation and the insufficiency of data initiated us to identify the green lacewing collection of the Gembloux Agricultural University, where lacewings from different parts of Belgium (mainly from the territory of the French-speaking Community) were preserved, and also to start a more or less regular collection of chrysopids at least in the surroundings of Gembloux in order to make a revision of Belgian chrysopids and to prepare an up-to-date checklist.

SITES AND METHODS OF COLLECTION

The first data were gained by determination of the pinned material of the Gembloux Agricultural University. Unfortunately one part of the specimens was damaged which often prevented the determination of the sex. These individuals are represented by the abbreviation of "adult" (ad). The deficiency and illegibility of some of the labels resulted in troubles, too: it was not possible to define partly the true and exact date and place of collection and practically there was no information on the method of collection and the habitat where the lacewings were captured. The probable imprecise details are represented by question mark(s). Administrative areas appear after the locality in parenthesis.

In 1995 (from July 12 until October 22) and 1997 (from June 7 till August 13) (samples were taken by using sweep net (30 cm diameter; 100 sweeps per sample) mainly in the territory of the Gembloux Agricultural University (Gembloux, Belgium). Sampled localities were: Experimental Area, Botanical Garden, Park of the Agricultural University, Natural Reserve of Gembloux and an uncultivated garden. In most cases living specimens were identified immediately after capturing or they were preserved in a 5% glycerol solution in 70% ethanol. Individuals were determined according to the descriptions of ASPÖCK *et al.* (1980).

RESULTS AND DISCUSSION

Pinned lacewings from the Collection of the Gembloux Agricultural University

Chrysoperla carnea (STEPHENS, 1836) *sensu lato*

Without date: ♀ Montigny?; ♀ Houtain-Saint- Siméon (Oupeye)

1983: 03.02 (= the 3rd February) ♀ Saint Servais (Namur); 03.06 ♀ Embourg (Chaudfontaine); 15.07 ♂ Marloie (Marche-en-Famenne); 19.07 ad Sart-Custinne (Gedinne)0; 20.07 ♂ Forest (Forest); 21.07 ♀ Chatelineau (Châtelet); 21.07 ♂ Gembloux (Gembloux); 26.07 ♂ Jette (Jette); 30.07 ♀ Slins (Juprelle); ??.08 ♂ Bruxelles (Bruxelles); 05.08 ♀ Jemappes (Mons); 17.08 ♀ Longueville (Chamant-Gistoux); 27.08 ♀ Ottignies (Louvain-la-Neuve); 30.08 ♀ Mons (Mons); 31.08 ♀ Gembloux (Gembloux); 08.09 ♀ Gembloux (Gembloux); 07.09 ♀ Rochefort (Rochefort); 17.09 ♀ Andoy (Namur); 28.09 ♀ La Louvière (La LouviPre); 01.10 ♀ Libin (Libin); 03.10 ad Châtelet (Châtelet); 09.10 ♀ Bourdon (Hotton); 10.10 ♂ Bruxelles (Bruxelles); 11.10 ♀ Rochefort (Rochefort);17.10 ♂ Gembloux (Gembloux); 28.10 ♀ Aiseau (Aiseau-Presles); 08;11 ♀ Mettet (Mettet); 08.11 ♀ Mettet (Mettet); 05.12 ♂ Lustin (Profondeville); 11.12 ♀ Rochefort (Rochefort)

1984: 22.?? ♀ Gembloux (Gembloux); ??.?? ♀ Tihange (Huy); 22.?? ♀ Nethen (Grez-Doiceau); 21.01 ♀ Lompret (Chimay); 02.02 ♂ Stembert (Verviers); 20.02 ♂ Fontaine l'Evêque (Fontaine l'Evêque); 03.03 ♂ Saint-Hubert (Saint-Hubert); 08.04 ♂ Aiseau (Aiseau-Presles); 0904 ♀ Awans (Awans); 10.04 ♂ Jambes (Namur); 11.04 ♂ Lisogne (Dinant); 11.04 ♀ Ciply (Mons); 13.04 ♀ Beausaint (La Roche-en-Ardenne); 15.04 ♀ Verviers (Verviers); 15.04 ♀ Gembloux (Gembloux); 15.04 ♀ Esneux (Esneux); 16.04 ♀ Forges (Chimay); 17.04 ♂ Auvelais (Sambreville); 18.04 ♀ Court-Saint- Etienne (Court-Saint-Etienne); 20.04 ♀ Sars Longchamps (La Louvière); 20.04 ♀ Hondeng-Aimeries (La Louvière); 28.04 ♂ Esneux (Esneux); 29.04 ♀ Rendeux-bas (Rendeux); 29.04 ♂ Visé (Visé); ??.05 ♀ Gembloux (Gembloux); 07.05 ♂ Ligny (Sombreffe); 08.05 ♀ La Louvière (La Louvière); 11.05 ♀ Marcinelle (Charleroi); 25.05 ♀ Mazy (Gembloux); 28.05 ♀ Chimay (Chimay); 30.05 ♀ Ligny (Sombreffe); 10.06 ♀ Celles (Lez Tournai)(Celles); 15.06 ♂ Ceroux-Mousty (Ottignies-Louvain-la-Neuve); 16.06 ♀ Dottignies (Mouscron); 30.06 ad Jambes (Namur); 25.07 ♂ Jemeppe-sur-Sambre (Jemeppe-sur-Sambre); ??.08 ♀ Gembloux (Gembloux); 13.08 ♀ Gembloux (Gembloux); 21.08 ♀ Gembloux (Gembloux); 25.08 ♀ Héron (Héron); 26.08 ♂ Mariemburg (Couvin); 03.09 ♂ Bleret (Waremme); 13.10 ♂ Tongrinne (Sombreffe)

1985: 23.09 ♀ Falmignoul (Dinant); 27.09 ad Beuzet (Gembloux); 15.11 ad Martelange (Martelange);

1986: 05.05 ad Estinnes-au-Val (Estinnes); 30.05 ♀ Ceroux-Mousty (Ottignies-Louvain-la-Neuve); 02.07 ad Gembloux (Gembloux); 12.08 ad Ham-sur-Heure (Ham-sur-Heure-Nalinnes); 23.08 ad Saint-Gilles (Saint-Gilles); 24.08 ♀ Limal (Wavre); 25.08 ad Sauvenière (Gembloux);

1989: 05.05 ♂ Spy (Jemeppe-sur-Sambre); 05.11 ♀ Châtelet (Châtelet)

Chrysopa perla (LINNAEUS, 1758)

1983: 31.05 ♀ Beauvechain (Beauvechain); 10.06 ♂ Gembloux (Gembloux); 12.06 ♂ Dour (Dour); 12.06 ♂ Cerfontaine (Cerfontaine); 26.06 ♂ Awans (Awans); ??.07 ad Harmignies (Mons);

15.07 ♂ Molenbeek-Saint-Jean (Molenbeek-Saint-Jean); 21.07 ♂ Gembloux (Gembloux); 23.07 ♀ Ottignies (Louvain-la-Neuve)

1984: 15.04 ♂ Forville (Fernelmont); 21.04 ♂ Natoye (Hamois); 06.05 ♂ Florennes (Florennes); 15.05 ♂ Gembloux (Gembloux); 20.05 ♂ Woluwé-Saint-Lambert (Woluwé-Saint-Lambert); 26.05 ♀ Dilbeek (Dilbeek); 01.06 ♂ Elouges (Dour); 02.06 ♂ Kehlen?; 07.06 ♂ Mazy (Gembloux); 07.06 ♂ Gembloux (Gembloux); 09.06 ♂ Gembloux (Gembloux); 09.06 ♂ Verviers (Verviers); 10.06 ad Ivoz-Ramet (Flémalle); 10.06 ♂ Philippeville (Philippeville); 12.06 ♂ Jamioulx (Ham-sur-Heure-Nalinnes); 15.06 ♂ Seneffe (Seneffe); 15.06 ♂ Wavre (Wavre); 16.06 ♀ Tertre (Saint-Ghislain); 16.06 ♂ Seneffe (Seneffe); 17.06 ♀ Braine-l-Alleud (Braine-l-Alleud); 20.06 ♂ Gembloux (Gembloux); 23.06 ♀ Jupille-sur-Meuse (Liege); 26.06 ♀ Gembloux (Gembloux); 27.06 ♂ Gembloux (Gembloux); 29.06 ♂ Gembloux (Gembloux); 12.07 ♀ Jemeppe (Jemeppe-sur-Sambre); 21.07 ♀ Molenbeek-Saint-Jean (Molenbeek-Saint-Jean); 07.08 ♂ Gembloux (Gembloux); 10.08 ad Bernimont (Léglise); 10.08 ♀ Bernimont (Léglise); 30.08 ♂ Frisée (Hamois)

1986: 20.06 ad Haillot (Ohey); 05.07 ad Liège (Liège); 05.07 ♀ Bertogne (Bertogne); 07.07 ♂ Kain (Tournai); 18.07 ♂ Gembloux (Gembloux); 02.08 ad Namur (Namur)

1989: 10.07 ♀ Walhain-Saint-Paul (Walhain); 24.08 ad Gembloux (Gembloux)

Chrysopa pallens (RAMBUR, 1838)

1987: 12.07 ad Kain (Tournai)
1984: 16.06 ♀ Mazy (Gembloux)

Nineta flava (SCOPOLI, 1763)

1982: 13.08 ad Xhendelesse (Herve)
1984: 09.08 ♀ Houtain-Saint-Simèon (Oupeye)

Dichochrysa prasina (BURMEISTER, 1839)

1984: 22.08 ♀ Gembloux (Gembloux); 26.08 ♂ Silenrieux (Cerfontaine)

Dichochrysa flavifrons (BRAUER, 1850)

1984: 25.08 ♀ Angleur (Liège)

Chrysopa phyllochroma WESMAEL, 1841

1986: 10.07 ad Gottignies (Le Roeulx)

The 137 specimens of 7 species of the collection were caught during 7 years (1982–1987, 1989) in 102 localities of Belgium (mainly in the south of the country). *Chrysoperla carnea* and *Chrysopa perla* predominated amounting 59.1 and 35% of the individuals while the rest of species *Chrysopa pallens, Ch. phyllochroma, Nineta flava, Dichochrysa prasina* and *D. flavifrons* seemed to be quite sporadic (Table 1). However, according to the contradiction between the numerous collection sites and the extremely low number of individuals captured the collectors must have caught almost incidentally the lacewings.

Results of the collections at Gembloux

1652 individuals of 7 species were captured through 4 months in 1995 at the Experimental Area (Table 1). Also *Chrysoperla carnea* and *Chrysopa perla* were the dominant species but *Dichochrysa prasina* was relatively permanent and common, too. The other species occurrence and abundance were occasional.

587 specimens of 7 chrysopid species were captured in 1997. *Chrysoperla carnea* was absolutely dominant whereas *Dichochrysa prasina, Nineta flava* and *Cunctochrysa albolineata* occurred relatively often. *Dichochrysa flavifrons*, *Chrysopa perla* and *Nineta pallida* were found only singly (Table 1).

Altogether 2376 specimens of 10 lacewing species were collected and identified according to our findings during the last 18 years in Belgium (Table 2). *Chry-*

Table 1. List of lacewing adults of the pinned collection and those collected in 1995 and 1997 (Gembloux, Belgium) (% = percent of dominance values)

Species	Pinned collection		1995		1997	
	No.	%	No.	%	No.	%
Ch. carnea	81	59.1	1604	97.09	562	95.74
Ch. perla	48	35.0	24	1.45	1	0.17
D. prasina	2	1.5	16	0.97	10	1.70
N. flava	2	1.5	1	0.06	6	1.02
D. flavifrons	1	0.7	5	0.30	1	0.17
C. albolineata	–		1	0.06	6	1.02
Ch. pallens	2	1.5	–		–	
Ch. phyllochroma	1	0.7	–		–	
D. ventralis	–		1	0.06	–	
N. pallida	–		–		1	0.17
Total number of species	7		7		7	
Total number of individuals	137		1652		587	

Table 2. List of lacewing adults collected in 1982–1997 (Belgium)

Species	Occurrence (months)	No.	%
Ch. carnea	1–12	2247	94.57
Ch. perla	4,5,6,7,8	73	3.07
D. prasina	7,8,9	28	1.18
N. flava	7,8	9	0.38
D. flavifrons	7,8	7	0.29
C. albolineata	7,8	7	0.29
Ch. pallens	6,7	2	0.08
Ch. phyllochroma	7	1	0.04
D. ventralis	7	1	0.04
N. pallida	7	1	0.04
Total number of species		10	
Total number of individuals		2376	

soperla carnea was really ordinary and frequent everywhere as it was indicated previously (NAVÁS 1913). The former status of *Chrysopa perla*, common far and wide in Belgium (NAVÁS 1913), can be agreed, too. And that is the case also with *Dichochrysa prasina* that can be characterized as a common and generally wide-spread species. *Nineta flava, Chrysopa pallens* and *Dichochrysa flavifrons* were classified as quite common or generally wide-spread lacewings (NAVÁS 1913) but considering the afore said results, *Ch. pallens* seems to be rather rare and neither of the two other species could be designated frequent. The previous occurrence characteristics of *Chrysopa phyllochroma, Cunctochrysa albolineata* and *Dichochrysa ventralis* were rare or quite rare and that is right for the present situation. About *Nineta pallida* there was no data at all, *ergo* it seems to be new for the Belgian fauna. Almost all of the rare species, *N. flava, N. pallida, Ch. pallens, C. albolineata, D. ventralis* and *D. flavifrons* can be found in the neighbouring countries (the Netherlands, Luxembourg, France, Germany, Great Britain), except *N. pallida* missing in the Netherlands, Luxembourg and Great Britain (ASPÖCK *et al.* 1980). The finding of *N. pallida* is really probable and valid because this species has been found also in collections in Sweden and Denmark (POPOV 2000, pers. comm.).

The number of species (*Nothochrysa fulviceps, Nothochrysa capitata, Hypochrysa elegans, Nineta vittata, Chrysotropia ciliata, Chrysopa formosa, Chrysopa dorsalis, Chrysopa abbreviata*) that have not been detected since 1913 in Belgium is considerable, too. These species were verified in the neighbouring countries with the exception of *N. capitata* missing in both Luxembourg and France, *H.*

elegans lacking in Luxembourg and Great Britain and *Ch. formosa* missing in the Netherlands, Luxembourg and Great Britain (ASPÖCK *et al.* 1980). One of them (*Chrysotropia ciliata*) have been found at Gembloux, too. It is highly probable that the species living in the Netherlands can find favourable conditions, habitats also in Belgium, thus their missing in collections is only a consequence of the insufficient investigation.

Regarding the previously stressed lack of data on Belgian lacewings, also their monthly occurrence is presented in Table 2 as complementing information.

The sibling species of *Chrysoperla carnea* complex have been identified but their data were published elsewhere (BOZSIK 2000).

CONCLUSIONS

According to the cited references and the results of the present publication 18 chrysopid species have been verified in Belgium (*Nothochrysa fulviceps, N. capitata, Hypochrysa elegans, Nineta vittata, N. flava, N. pallida, Chrysotropia ciliata, Chrysopa pallens, Ch. abbreviata, Ch. phyllochroma, Dichochrysa flavifrons, D. prasina, D. ventralis, Chrysopa perla, Ch. formosa, Ch. dorsalis, Chrysoperla carnea, Cunctochrysa albolineata*). One species, *N. pallida* proved to be new for the Belgian fauna. Considering that the Belgian lacewing fauna has been understudied, the presented results could be seen only as the first attempts to change this poor situation.

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INFLUENCE OF THE DENSITY OF CHRYSOPERLA MEDITERRANEA (HÖLZEL, 1972) (NEUROPTERA: CHRYSOPIDAE) ADULTS ON ITS LABORATORY REPRODUCTION POTENTIAL

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The reproductive potential of *Chrysoperla mediterranea* (HÖLZEL, 1972) was investigated, when adults were subjected to different densities per rearing unit. Couples after emergence were placed into rectangular cages of 450 cm^3, fed enzymatic protein hydrolysate of yeast and kept in a climatic chamber at 20±1 °C, RH 70–80% and 16h-photophase. The treatments were repeated six times utilizing 1, 2, 3, 4, 5, 6 and 7 couples with a couple/volume ratio of 1/450, 1/225, 1/150, 1/112, 1/90, 1/75 and 1/64 cm^3, respectively. It was observed that the average pre-oviposition period for one couple was 5.8±0.3 days while for the other treatments it was 7–8 days. For the oviposition period no significant differences were found, 100 days being obtained on the average, but for the daily and total oviposition the results showed differences among the treatments with one couple per rearing unit showing the greatest fecundity (520±26.0 eggs/female). By increasing the couple numbers, the total oviposition capacity decreased, becoming more marked from four couples per rearing unit, with only 270.0±103.0 eggs/female when seven couples were utilized (density 1/64 cm^3). Longevity was equally affected by density and for a single couple, it was 138.3±11.2 days for the males and 117.8±12.8 days for the females. In comparison, the reduction was in the order of 50% for both sexes when the density was seven couples per chamber.

Key words: green lacewing, *Chrysoperla*, biology, rearing units

INTRODUCTION

Research on Neuroptera: Chrysopidae, and especially that devoted to species of the genus *Chrysoperla* STEINMANN, 1964, has stressed the importance of this predaceous group for the biological control of a number of arthropod pests in many important crops. Thus, when one wishes to make releases of these entomophagous insects in integrated pest management programs (IPM) (TAUBER *et al.* 2000), it is necessary to establish laboratory colonies for the production of different developmental forms.

Using the current rearing techniques of adults for green lacewings, KARELIN *et al.* (1989) determined that the density of adults per rearing unit was an important factor in the egg production of *Chrysoperla carnea* (STEPHENS, 1836) "sensu

lato". By utilizing 30 couples per dm^3 the best fecundity was obtained, however, in about 25 days there was a reduction in egg production, and the destruction of adults was suggested. ARÁUJO and BICHÃO (1990) demonstrated that the best performance of adults of the same species was obtained with one couple/40 cm^3 and the destruction of the rearing material after 35–40 days. Considering the number of adults in the rearing units, the couple/volume ratio, maintenance of the adults, the size and the shape of the rearing boxes, a huge variation is found, stressing that essential experimental conditions are critical and there is a need for the determination of suitable rearing conditions for each species (FINNEY 1948, 1950, MORRISON & RIDGWAY 1976, FERRAN *et al.* 1981, MORRISON 1985, SISSOKO 1987, NÚÑEZ 1988, SAMSØE-PETERSEN *et al.* 1989, VENZON & CARVALHO 1992, RIBEIRO *et al.* 1993). Thus, the aim of this study was to determine the suitable density for rearing and time for the destruction of *Ch. mediterranea* (HÖLZEL, 1972) adults through the evaluation of the main biological parameters in the adult stage.

MATERIAL AND METHODS

The experiment was conducted in a chamber at 20±1 °C, RH 70–80% and 16-hour photophase by utilizing 1, 2, 3, 4, 5, 6 and 7 couples of *Ch. mediterranea* placed in transparent plastic boxes of 12.8×7.0×5.0 cm (about 450 cm^3) feeding on enzymatic protein hydrolysate of yeast. The couple/volume ratio was of 1/450, 1/225, 1/150, 1/112, 1/90, 1/75 and 1/64 cm^3, respectively. A piece of 5.0×6.0 cm folded paper was placed on the bottom of each rearing unit as a shelter, and for oviposition, a strip of 2 cm wide absorbent paper of white color was put on the upper part of the rearing boxes, and was utilized soon after mating. The experimental scheme was a completely randomized design with seven treatments and six replications. The evaluated parameters were: pre-oviposition period, daily oviposition and total number of eggs/female, males' and females' longevity and time of maintenance of the adults in rearing chamber.

RESULTS AND DISCUSSION

The results appear in Table 1. The observed pre-oviposition period of *Ch. mediterranea* may be divided into two groups. The first one showed an average of 5.8±0.3 days and the other one ranged from 7.2 to 8.2 days. In terms of the increased number of couples per rearing units, there was a lengthening of the pre-oviposition period; making it evident that the maximum density must be no more than 1 couple per 112 cm^3. By comparing treatments 2, 3 and 4 to the first one, an increase of 27% was observed. However, considering the treatments of 5, 6 and 7 couples, the pre-oviposition period was increased by 41%, confirming the results of SAMSØE–PETERSEN *et al.* (1989) for adults of *Ch. carnea* maintained un-

der a crowded regime. Another factor which may affect the pre-oviposition period in *Ch. mediterranea* is adult feeding and individuals provided with a feeding regime considered optimum (for example yeast + honey 1:1) had a pre-oviposition period ranging from 5.5 to 6.5 days.

The results obtained for the oviposition period discovered that there were no significant differences among the several densities utilized. Even the mean obtained for the adults of treatment 7 of 92.3±7.3 days was not different significantly from the others. The tests showed that the increase in density may be able to reduce the oviposition period and thus to affect the oviposition capacity and the time of maintenance of the adults in rearing.

The daily average fecundity for couples kept singly (1 couple), was of 6.2±0.9 eggs/female, significantly different from the other treatments, the general mean of which was of 3.3±0.1 eggs/female. It was found that independently of the density of adults utilized, beyond 1 couple/chamber, there was an average reduction of about 50% in the daily oviposition capacity of *Ch. mediterranea*, stressing the importance of the insect number per rearing unit on the daily oviposition capacity of this species. An important aspect which often makes it difficult the maintenance of adults is the oviposition site of the eggs which are deposited on different surfaces of the cage, complicating their collection. By attaching the absorbent paper strips to the rearing unit lid 90 to 100 % of the eggs were deposited there, which made their collection easier.

Considering the total number of eggs, the results were still more evident, showing that the isolated couples had a fecundity significantly superior to all the other treatments. The means obtained for treatments 2 to 6 were very close to each other, however, treatment 7 was very different and its mean is a half of that of treatment 1. A general comparison of those results showed that treatment 6 (1 couple/75 cm^3) with a mean of 356.3±42.3 eggs/female, seeming to be the limit to that type of rearing.

Considering that the adults were fed only on enzymatic yeast hydrolysate and comparing this to the results obtained by CARVALHO *et al.* (1996) upon the reproductive capacity of adults of *Chrysoperla externa* (HAGEN, 1861) and *Ch. mediterranea* fed on different artificial diets, it is clear that the diets utilized strongly influence fecundity. Those species of green lacewing and when kept singly on other diets could produce on the average, 2,200 eggs, or four times the number of eggs obtained for treatment 1. So, one can imagine that changes of the diet will be able to influence and induce a substantial increase in oviposition capacity, even when the females were kept in a collective regime, but, more research on *Ch. mediterranea* adults is necessary. In addition to the density, feeding, temperature, relative humidity and photoperiod factors, it is necessary to study the shape of the rearing

Table 1. Periods of pre-oviposition, oviposition, daily and total fecundity, and longevity of males and females of *Chrysoperla mediterranea* under different densities

Couples per box	Period (days)		Fecundity (N.)		Longevity (days)	
	Pre-oviposition	Oviposition	Daily	Total	Males	Females
1	5.8 b	106.5 a	6.2 a	520.0 a	138.3 a	117.8 a
2	7.2 a	116.2 a	3.2 b	350.3 ab	97.0 b	102.2 ab
3	7.8 a	109.5 a	3.2 b	317.0 ab	117.0 a	100.3 ab
4	7.2 a	119.8 a	3.8 b	421.0 ab	94.7 b	87.7 bc
5	8.0 a	111.5 a	3.1 b	320.9 ab	89.5 b	86.2 bc
6	8.2 a	106.7 a	3.4 b	356.3 ab	84.0 bc	80.7 bc
7	8.2 a	92.3 a	3.2 b	270.9 b	70.0 c	68.3 c

units. KARELIN *et al.* (1989) stated that the substitution of rectangular cages for cylindrical ones resulted in an increase of 27 to 30% in the coefficient of the utilization of the cage area by *Ch. carnea* adults.

Survival of the adults kept singly or under collective regimes must be observed independently of the experimental conditions. For example, females' longevity was shorter than that of males' in relation to density, and with a reduction trend of longevity in both sexes has been observed. For the males, except treatment 2, the density reduction was gradual, except for treatment 7 with mean of 70.0±3.7 days, which differed significantly from the others. By comparing treatments 1 and 7, a reduction in the longevity of about 50% was noticed. For the females, the results were similar and longevity was reduced in relation to the increase of adults per rearing unit. The longevity means observed in case of the couples kept collectively ranged from 68.2 to 102.2 days.

In general and considering the females' longevity and ending the rearing of lacewing adults, it was verified that they are factors intrinsically related to the species. SAMSØE-PETERSEN *et al.* (1989), MORRISON and RIDGWAY (1976), KARELIN *et al.* (1989) and ARAÚJO and BICHÃO (1990) working on *Ch. carnea* "sensu lato" and RU *et al.* (1976) dealing with *Chrysoperla rufilabris* (BURMEISTER, 1839), suggested that the adults should be destroyed after 15–40 days of confinement. Thus analyzing the results obtained for the daily and total fecundity and longevity of the *Ch. mediterranea* females, it is apparent that the best reproduction performance of the adults reared collectively and fed on enzymatic protein hydrolysate of yeast, is with a maximum of 1 couple/112 cm^3 (treatment 4). As regards the destruction of adults, it is apparent that it should be accomplished only after 75 to 85 days when 80 to 90% of the oviposition has been realized.

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The Fauna of the Bükk National Park

VOLUME I

edited by
S. MAHUNKA and L. ZOMBORI

The seventh part of the series "Natural History of the National Parks of Hungary" comprises a collection of papers written by thirty-seven Hungarian and foreign experts. This is the first volume which discusses a large share of the scientifically elaborated material deriving from the territory of the Bükk National Park (North Hungary).

The book opens with a preface written by Dr. J. Tardy, deputy secretary of state, who gives his "Reflections on nature conservation in Hungary, 1993", followed by an editorial Introduction having a detailed list of all the larger administrative and also minor locality names, some of which are amply shown in a map. The volume proper is divided into two sections: Mollusca and Arthropoda. The latter, by far the biggest section, is a collection of scientifically highly valuable contributions on the following groups of animals: Mallophaga (4 pp), Heteroptera (4 pp), Homoptera (8 pp), Coleoptera (80 pp), Lepidoptera (162 pp), Diptera (82 pp), Siphonaptera (6 pp), Hymenoptera (42 pp), Acari (5 pp). The book closes with an Index to Authors.

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NEUROPTERA IN OAK FORESTS IN THE SUBMEDITERRANEAN DISTRICT OF SLOVENIA

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In the Submediterranean District of Slovenia, Neuropteran assemblages in two types of oak forests have been investigated. For both forest types, data on plant substrate species are provided. The faunal composition of the two oak forests is compared with the fauna of the garrigue from the southernmost part of Istria. While in both woodland habitats arboreal species dominate, in the garrigue habitat the number of species preferring grassy steppes is much higher.

Key words: Neuroptera, Istria, Submediterranean District, oak forests

INTRODUCTION

Neuropteran communities in natural forests are generally poorly known. Woodland habitats show a mixed vegetation structure, so that the Neuropteran fauna in most cases is also a diverse one. Chrysopid assemblages in West Palaearctic temperate forests are presented by ZELENÝ (1984). Lacewing populations in European coniferous forests have been studied by CZECHOWSKA (1985), and in deciduous forests by PANTALEONI (1984), CZECHOWSKA (1990) and SZIRÁKI (1996). Plant substrate specificity of Iberian Coniopterygidae and Chrysopidae has been studied by MONSERRAT and MARÍN (1992, 1994). For a review see also STELZL and DEVETAK (1999).

In the present study, the faunal composition of two oak forests in the Slovenian part of Istria has been investigated. Istria lies in the NW part of the Balkan Peninsula. The characteristic vegetation of the area consists of several types of Submediterranean woodland and scrub communities (for review see DEVETAK, 1998).

MATERIAL AND METHODS

The first forest type studied, located near Strunjan (Fig. 1), represents a fragment of macchia, which is a result of the destruction of the original Mediterranean sclerophyll forest. This fragment is classified as *Orno-Quercetum ilicis* subass. *cotinetosum*. The characteristic tree species, evergreen oak (*Quercus ilex*), occurs only sporadically. Common plant species include *Quercus pubescens, Ostrya carpinifolia, Fraxinus ornus, Myrtus communis, Cotinus coggygria* and *Spartium junceum*.

The second forest type, located at Osp (Fig. 1), belonging to the Submediterranean deciduous forests with *Quercus pubescens*, *Ostrya carpinifolia* and *Carpinus orientalis* as dominant tree species, is classified as *Ostryo-Quercetum pubescentis* subass. *pistacietosum terebinthi*. Other frequently occurring plant species are *Fraxinus ornus, Acer monspessulanum, Pistacia terebinthus* and *Celtis australis*.

The neuropteran fauna of the two oak forest was compared with the garrigue from the southernmost part of Istria (near Premantura, Fig. 1). This garrigue habitat is classified as *Cisto-Ericetum arboreae*.

Between May and September 1997, seven one-day samplings were carried out in the two forest habitats. Insects were collected by beating the vegetation with a handnet.



Fig. 1. Map of Istria with collecting sites

RESULTS AND DISCUSSION

Altogether, 157 individuals, belonging to 17 neuropteran species, were collected from the two forest habitats (Table 1). The most abundant species were *Dichochrysa flavifrons* (STEIN), *Hemerobius micans* OLIVIER, *Semidalis aleyrodiformis* (STEPHENS) and *Chrysoperla lucasina* (LACROIX).

Table 2 shows the neuropteran species arranged according to their recorded plant substrate. *Dichochrysa flavifrons* was collected on ten tree species and seems to be the most eurytopic species. The species *Semidalis* sp., *Hemerobius micans, Dichochrysa abdominalis* (BRAUER) *and Chrysoperla lucasina* are also very eurytopic, collected from five or more plant species. Most likely the unidentified species is *Semidalis aleyrodiformis* (females) because the specimens were collected on deciduous trees and shrubs, and not *Semidalis pseudouncinata* MEINAN-

Table 1. List of species of Neuroptera recorded in the oak forest habitats at Strunjan and Osp during 1997

Species	Osp	Strunjan
Coniopterygidae		
1. *Coniopteryx lentiae* H. ASPÖCK & U. ASPÖCK, 1964	+	
2. *Semidalis aleyrodiformis* (STEPHENS, 1836)	+	+
3. *Semidalis pseudouncinata* MEINANDER, 1963		+
Hemerobiidae		
4. *Wesmaelius subnebulosus* (STEPHENS, 1836)	+	+
5. *Hemerobius humulinus* LINNAEUS, 1758		+
6. *Hemerobius micans* OLIVIER, 1792	+	+
7. *Hemerobius gilvus* STEIN, 1863		+
8. *Sympherobius pygmaeus* (RAMBUR, 1842)	+	+
Chrysopidae		
9. *Nineta flava* (SCOPOLI, 1763)		+
10. *Chrysopa perla* (LINNAEUS, 1758)		+
11. *Chrysopa formosa* BRAUER, 1850		+
12. *Chrysopa viridana* SCHNEIDER, 1845	+	+
13. *Dichochrysa flavifrons* (BRAUER, 1850)	+	+
14. *Dichochrysa abdominalis* (BRAUER, 1856)	+	+
15. *Dichochrysa zelleri* (SCHNEIDER, 1851)		+
16. *Chrysoperla lucasina* (LACROIX, 1912)	+	+
Myrmeleontidae		
17. *Euroleon nostras* (GEOFFROY in FOURCROY, 1785)	+	+

DER which inhabits Cupressaceae. On the other hand, some neuropteran species were recorded from only one plant substrate species. These species are *Coniopteryx lentiae* ASPÖCK et ASPÖCK, *Semidalis pseudouncinata*, *Hemerobius humulinus*, *H. gilvus* STEIN, *Nineta flava* (SCOPOLI), *Chrysopa perla* (L.) and *Dichochrysa zelleri* (SCHNEIDER). At least some of these species are known in European temperate forests as eurytopic.

Table 2. Neuroptera on different substrate species in Osp and Strunjan

Neuropteran species	No. of substrate species	Substrate species
Coniopteryx lentiae	1	*Ostrya carpinifolia*
Coniopteryx sp.	3	*Ostrya carpinifolia, Quercus pubescens, Q. ilex*
Semidalis aleyrodiformis	4	*Cotinus coggygria, Crataegus sp., Fraxinus ornus, Ostrya carpinifolia*
Semidalis pseudouncinata	1	*Cupressus sempervirens*
Semidalis sp.	6	*Cotinus coggygria, Crataegus sp., Fraxinus ornus, Hedera helix, Quercus pubescens, Q. ilex*
Wesmaelius subnebulosus	3	*Fraxinus ornus, Hedera helix, Paliurus spina-christi*
Hemerobius humulinus	1	*Cotinus coggygria*
Hemerobius micans	6	*Cotinus coggygria, Crataegus sp., Fraxinus ornus, Ostrya carpinifolia, Quercus pubescens, Q. ilex*
Hemerobius gilvus	1	*Quercus pubescens*
Sympherobius pygmaeus	4	*Carpinus orientalis, Fraxinus ornus, Ostrya carpinifolia, Quercus pubescens*
Nineta flava	1	*Quercus pubescens*
Chrysopa perla	1	*Cotinus coggygria*
Chrysopa formosa	2	*Fraxinus ornus, Spartium junceum*
Chrysopa viridana	2	*Fraxinus ornus, Quercus pubescens*
Dichochrysa flavifrons	10	*Acer monspessulanum, Carpinus orientalis, Celtis australis, Cotinus coggygria, Crataegus sp., Fraxinus ornus, Ostrya carpinifolia, Pistacia terebinthus, Quercus pubescens, Q. ilex*
Dichochrysa abdominalis	6	*Acer monspessulanum, Fraxinus ornus, Hedera helix, Pistacia terebinthus, Quercus pubescens, Q. ilex*
Dichochrysa zelleri	1	*Ostrya carpinifolia*
Chrysoperla lucasina	5	*Carpinus orientalis, Cotinus coggygria, Fraxinus ornus, Ostrya carpinifolia Quercus pubescens*

Table 3. Substrate species inhabited by Neuroptera

Substrate species	Osp		Strunjan	
	Number of species	Number of individuals	Number of species	Number of individuals
Acer monspessulanum	2	7	–	–
Carpinus orientalis	–	–	3	5
Celtis australis	1	1	–	–
Cotinus coggygria	2	2	6	18
Crataegus sp.	–	–	3	9
Cupressus sempervirens	–	–	1	1
Fraxinus ornus	3	8	8	21
Hedera helix	3	4	-	–
Ostrya carpinifolia	6	15	6	10
Paliurus spina-christi	1	1	–	–
Pistacia terebinthus	2	12	–	–
Quercus pubescens	1	1	10	24
Quercus ilex	–	–	5	6
Spartium junceum	–	–	1	1

Table 4. Neuropteran asssemblages in oak forests (with *Quercus pubescens* and *Q. ilex*; Osp and Strunjan) and in the garrigue (Cisto-Ericetum arboreae; Premantura)

Species	Oak forests	garrigue
Coniopterygidae		
Coniopteryx pygmaea ENDERLEIN, 1906		+
C. haematica MCLACHLAN, 1863		+
C. esbenpeterseni TJEDER, 1930		+
C. lentiae H. ASPÖCK & U. ASPÖCK, 1964	+	
Semidalis aleyrodiformis (STEPHENS, 1836)	+	
S. pseudouncinata MEINANDER, 1963	+	+
Mantispidae		
Mantispa styriaca (PODA, 1761)		+
Hemerobiidae		
Wesmaelius subnebulosus (STEPHENS, 1836)	+	
Hemerobius humulinus LINNAEUS, 1758	+	
Hemerobius micans OLIVIER, 1792	+	
Hemerobius gilvus STEIN, 1863	+	
Sympherobius pygmaeus (RAMBUR, 1842)	+	+

Table 4 (continued)

Species	Oak forests	garrigue
Chrysopidae		
Italochrysa italica (ROSSI, 1790)		+
Nineta flava (SCOPOLI, 1763)	+	
Chrysopa perla (LINNAEUS, 1758)	+	
Chrysopa dorsalis BURMEISTER, 1839		+
Chrysopa formosa BRAUER, 1850	+	
Chrysopa viridana SCHNEIDER, 1845	+	+
Chrysopa pallens (RAMBUR, 1839)		+
Dichochrysa flavifrons (BRAUER, 1850)	+	+
Dichochrysa abdominalis (BRAUER, 1856)	+	+
Dichochrysa zelleri (SCHNEIDER, 1851)	+	
Chrysoperla lucasina (LACROIX, 1912)	+	+
Myrmeleontidae		
Palpares libelluloides (LINNAEUS, 1764)		+
Euroleon nostras (GEOFFROY in FOURCROY, 1785)	+	
Macronemurus appendiculatus (LATREILLE, 1807)		+
Distoleon tetragrammicus (FABRICIUS, 1798)		+
Creoleon plumbeus (OLIVIER, 1811)		+
Ascalaphidae		
Deleproctophylla australis (FABRICIUS, 1787)		+
Libelloides macaronius (SCOPOLI, 1763)		+

Table 3 shows the numbers of species and individuals of Neuroptera recorded at the two oak forest locations for each of the recorded plant substrates.

The faunal composition of the two oak forests is compared with the fauna of the garrigue from the southernmost part of Istria (Table 4). Whilst in both woodland habitats arboreal species dominate, in the garrigue habitat the number of species preferring grassy steppes is much higher.

The number of species recorded in the oak forests is considered likely to be artificially low as a consequence of the brevity of the sampling period.

*

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The Fauna of the Bükk National Park

VOLUME II

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S. MAHUNKA, L. ZOMBORI and L. ÁDÁM

The eighth part of the series "Natural Histroy of the National Parks of Hungary" comprises a collection of papers written by forty-eight Hungarian and foreign experts. This is the second volume which discusses a large share of the scientifically elaborated material deriving from the territory of the Bükk National Park (North Hungary).

The volume proper is divided into five sections: Vermes (53 pp), Arthropoda (455 pp), Amphibia and Reptilia (36 pp), Aves (22 pp) and Mammalia (10 pp). The biggest section is Arthropoda, a collection of scientifically highly valuable contributions on the following groups of animals: Anomopoda and Copepoda (3 pp), Isopoda (4 pp), Odonata (20 pp), Orthopteroid insects (29 pp), Psocoptera (4 pp), Thysanoptera (18 pp), Heteroptera (4 pp), Homoptera (7 pp), Coleoptera (225 pp), Neuroptera (8 pp), Trichoptera (13 pp), Diptera (23 pp), Hymenoptera (49 pp), Acari (48 pp). The book closes with an Index to Authors and an Index to Volumes I and II.

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FOREST EDGES ARE BIODIVERSITY HOTSPOTS – ALSO FOR NEUROPTERA

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In a research project investigating the contribution of forest ecotone structures to regional arthropod biodiversity, the neuropteran fauna was assessed at five differently-structured forest edges and, for comparison, 50 m inside the forest. Arthropods were collected from February to November by means of pitfall traps, window (interception) traps and yellow water pans. The traps were installed along transects, reaching horizontally from the open cultivated land into the forest and vertically, on scaffolds, from the ground up to the tree crowns.
For each of the species of the insect orders Neuroptera (59), Raphidioptera (3) and Mecoptera (2), spatio-temporal distribution patterns from open habitats into the forest can be generated from the available database. Only 3 species (5%) were equally or more numerous inside the forest than at the edges. Of particular interest is the distribution in space and time of three sibling species of the *Chrysoperla carnea* complex (*C. lucasina, C. pallida, C. carnea*).
Neuroptera and Raphidioptera showed their highest species numbers in the shrub belt and the forest mantle, while the Mecoptera preferred the herbaceous fringe. Traps located deepest inside the forest yielded the lowest number of species. In the forest interior, species numbers peaked in the canopy. However, the canopy yielded markedly fewer species than the forest edges. Steep forest edges contained 24% more species than the forest interior, sloped, structurally rich forest edges even 60% more.

Key words: Neuroptera, Raphidioptera, Mecoptera, biodiversity, forest edge, canopy

INTRODUCTION

It is generally assumed that forests harbour the highest proportion of the world's biodiversity, and that the larger the forests are, the higher is the biodiversity they contain. While this may be true for virgin rain forests in the tropics, the situation in managed forests in temperate climates seems to be quite different.

For numerous taxa of the invertebrates, which contribute world-wide with more than 73% of all described organisms most to biodiversity, we tested the following hypotheses:

- so called "forest species" are in fact mainly forest-edge species, i.e. species numbers decline towards the forest interior;

– highly structured forest edges contain more species than abrupt or steep forest edges, because the latter lack ecotonal structures such as a proper shrub belt and/or a forest mantle.

We here report on the Neuroptera and Raphidioptera, insect orders known to be prevalently arboreal, as well as the Mecoptera, which also are generally associated with forests.

MATERIAL AND METHODS

Arthropod biodiversity was measured 1994 and 1995 at five differently structured forest edges and, for comparison, 50 m inside one of the forests (FLÜCKIGER & DUELLI 1997, FLÜCKIGER 1999). In addition, the results of these transects were linked to the data of a 5km-transect through agricultural and seminatural habitats, which had been assessed in the same region in 1987 (DUELLI *et al.* 1992, DUELLI & OBRIST 1995, DUELLI & OBRIST 1998). All study sites were located along the slopes of the Jura Mountains in north-western Switzerland.

Arthropods were collected with standardized faunistic sampling methods from February to November by means of pitfall traps, window (interception) traps (Fig. 1), and yellow water pans (DUELLI *et al.* 1999). The traps at the forest edges were installed along transects, reaching horizontally from the open cultivated land into the forest and vertically, on metal scaffolds, from the ground up to the tree tops.

The horizontal transects on the surface consisted of one trap station in each of the following ecotone structures: (1) cultivated land, traps at a distance of 10 m from the herbaceous fringe of the forest edge; (2) herbaceous fringe: (3) shrub belt, just behind the herbaceous fringe, but traps were displaced side-ways to keep a distance of at least 10 m to the station in the herbaceous fringe; (4) not commercially used forest beneath the forest mantle, just 1 m behind the shrub belt; (5) not commercially used forest ecotone 10 m inside the herbaceous fringe.

One of the horizontal transects through a highly structured forest edge ended with a trap station 50 m inside a beech forest. Here, a metal tower was placed for constructing a vertical transect, representing the forest interior. Trap stations were mounted on scaffolding at heights of 0 m (flight traps actually at 1.5 m above ground), 4 m, 12 m, 20 m, and 28 m.

The other vertical transects followed the smooth or steep slopes of the five forest edges. At the two highly structured (smooth) forest edges, traps were placed in steps of 4 m height up to the canopy. In the three steeper forest edges, the steps between heights were 8 m.

The data for all groups, including Neuroptera, Raphidioptera and Mecoptera, were processed in a faunistic data base, custom programmed in Oracle (Oracle Corporation, USA).

RESULTS

In the course of two years of collecting, 58 species of Neuroptera, 3 of the order Raphidioptera and 2 of the Mecoptera were collected. The family Hemerobiidae, with 26 species, contributed most to neuropteran diversity of forest edges, followed by the Chrysopidae with 18 species, and the Coniopterygidae with 13 species.

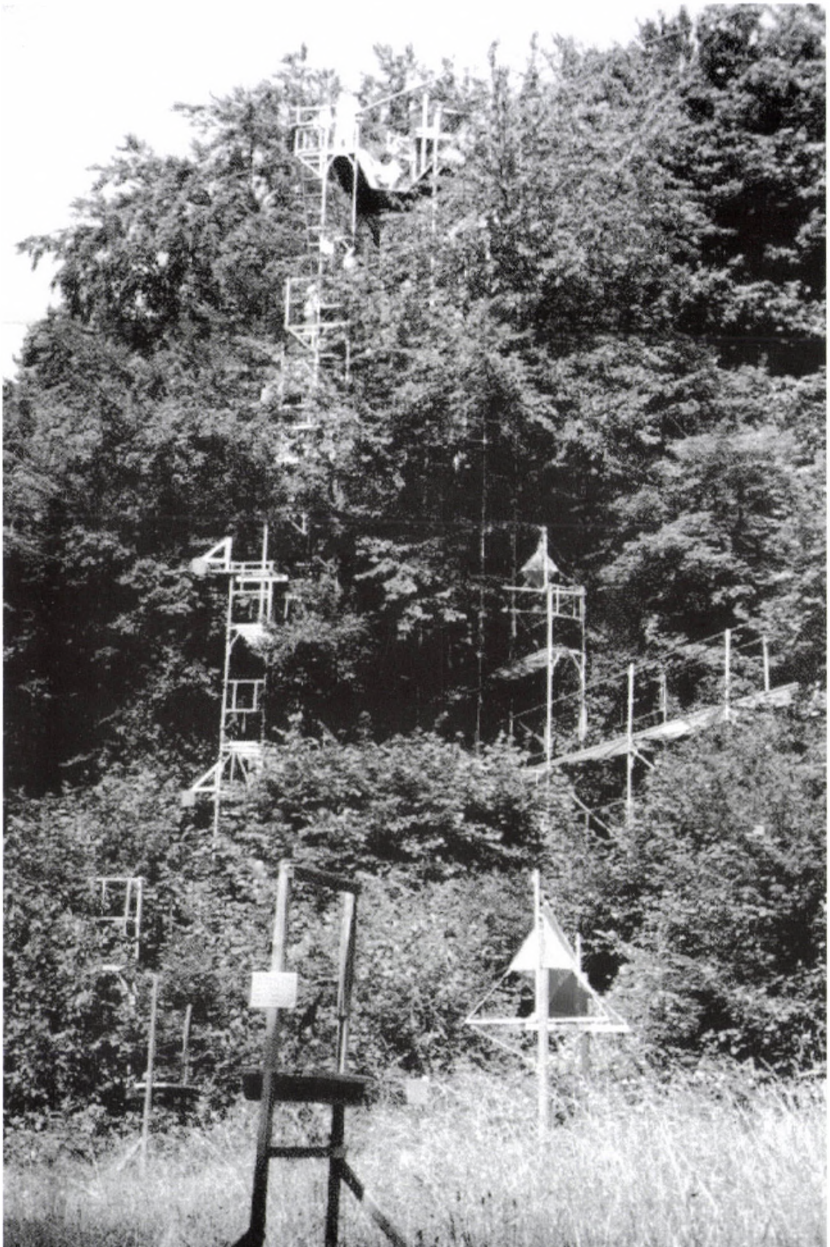


Fig. 1. Sloped, highly structured forest edge along a mixed beech forest at Rickenbach (Western Switzerland). One (horizontal) transect of trap stations (window interception trap in the foreground) started 10 m outside the herbaceous fringe of the forest edge and lead 50 m into the forest, the other (vertical) transect lead from the herbaceous fringe to the canopy

For each species, the distribution of the yearly catches was displayed on a standard chart showing the trap locations of the five forest edges and the forest interior in schematic form (example of *Nothochrysa fulviceps* shown in Fig. 2). Similarly, the species numbers of selected families, or all the families, can be displayed on such charts (Fig. 3).

Generally, species numbers were higher in the gently sloped (structured) forest edges, as compared to the steep forest edges, where the forest mantle and/or the shrub belt was missing. In those steep edges, the herbaceous fringe usually was right at the base of the first row of tall trees. On average, species numbers per trap

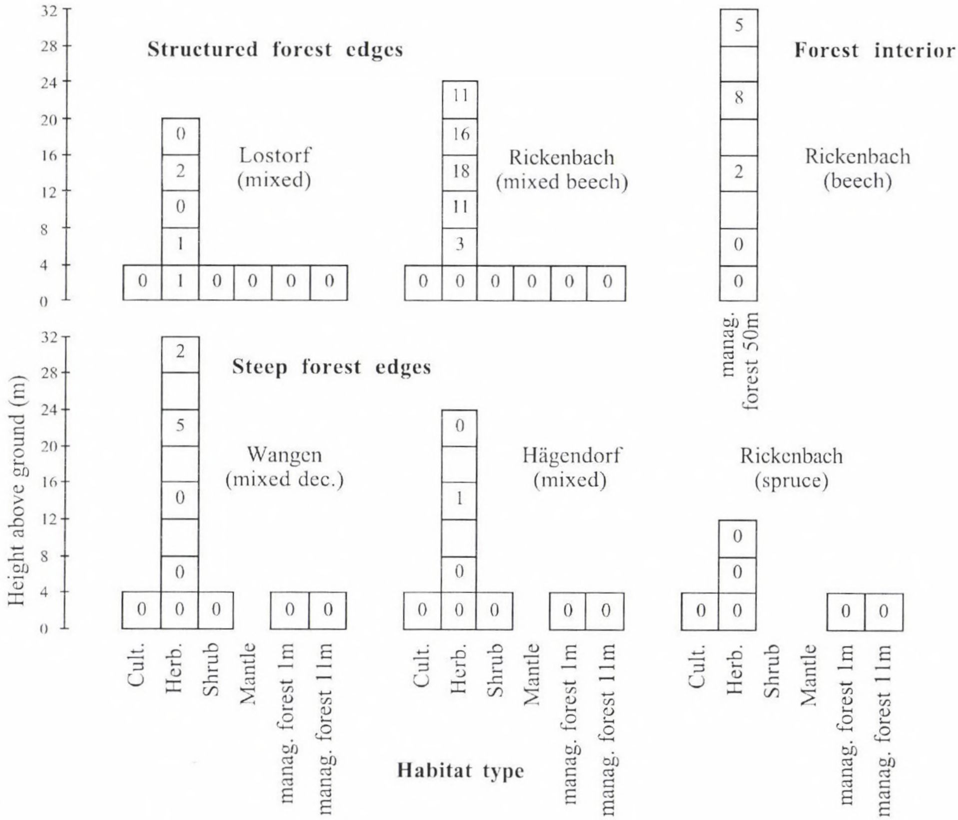


Fig. 2. Numbers of individuals of the chrysopid *Nothochrysa fulviceps* collected per year in the different trap stations of the two sloped, highly structured forest edges, the three steep edges, and the station in the forest interior, 50 m from the edge. The same distribution chart was performed for all 63 species collected during this project. Empty spaces in the horizontal transects mean that the particular forest structure was missing, empty fields in the vertical transects mean that there was no trap

height were lowest in the forest interior, 24% higher in the steep forest edges, and even 60% higher in the structured forest edges.

For a general overview of the spatial distribution of neuropteran diversity in and around forested areas, the yearly species numbers collected in the Rickenbach transect (mixed beech forest, gently sloped, with the control tower 50 m in the forest interior) are combined here with that of an earlier transect (DUELLI *et al.* 1992, DUELLI & OBRIST 1998), in which exactly the same trap types and the same collecting period had been applied in a nearby area. Fig. 4 clearly shows a maximum of species in the shrub belt and mantle of the forest edge. Away from the forest edge, as well as towards the forest interior, the species numbers decline rapidly. Of

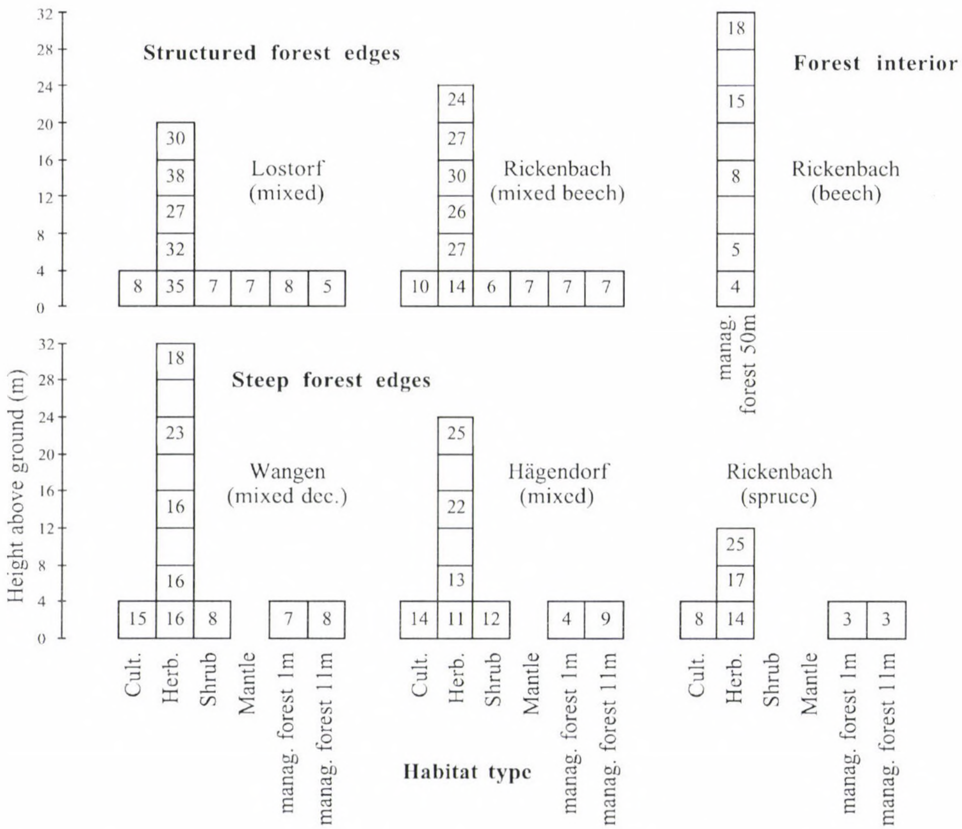


Fig. 3. The same format as shown in Fig. 2 can be used, as shown here, to display the species numbers per trap station per year (Neuroptera, Raphidioptera, Mecoptera). Empty spaces in the horizontal transects mean that the particular forest structure was missing, empty fields in the vertical transects mean that there was no trap

all the species of Neuroptera, Raphidioptera, Megaloptera and Mecoptera collected in this enlarged transect, only the two species of the order Megaloptera, *Sialis lutaria* and *S. fuliginosa*, were found to be more frequent outside the forest zone. All other species were most frequently collected in or along the forest. Within the forest, the canopy yielded the highest diversity (18 species), but still far less than the forest edge (30 species).

To test the hypothesis, that most species are in fact forest edge species, and not real forest (interior) species, the spatial distribution of each single species was qualified in a standardized chart cumulating and weighing the information from all forest edges and the forest interior. For each trap location in the idealized transect depicted as an example in Fig. 5, the number of specimens collected had to be divided by the number of traps available at that location. This procedure is only an approximation to the real distribution of a species, since not all trap sites in the chart of Fig. 5 had the same probability to collect at least one specimen. Some structures were lacking in certain forest edges, or the structure had been sampled for two years instead of only one.

The distribution of each species shown in the idealized transect of Fig. 5 led to an interpretation of the favourite habitat of that species. The relative figures (in %) allow for an arbitrary threshold (here 20%) to decide, which of the forest structures are preferred by the species in question. According to Fig. 5, *Phaeostigma*

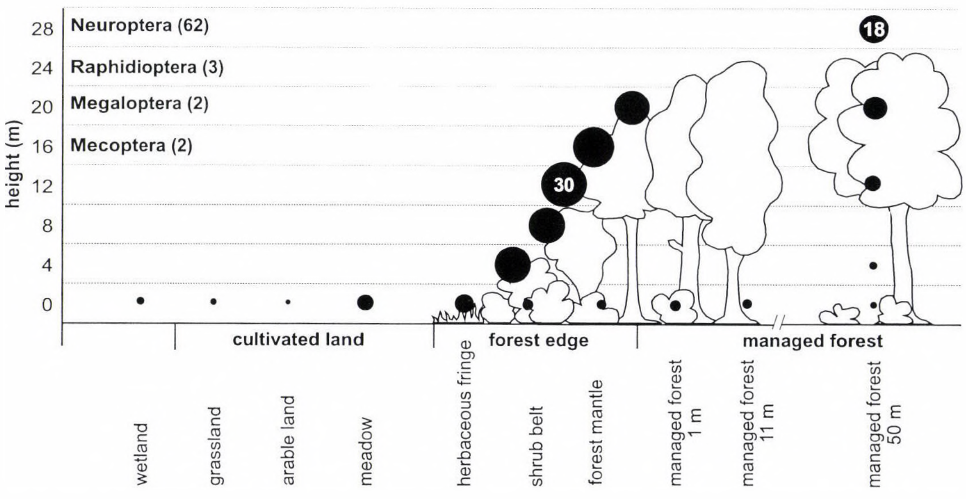


Fig. 4. Trap station transect extended from the Rickenbach forest edge into open country (agriculture, wetland). The size of the black dots indicates species richness per yearly catch. A maximum of 30 species was collected in the mantle structure, and 18 species in the forest canopy 50 m inside the forest. Two species of *Sialis* (Megaloptera) were restricted to the transect extension into open countryside

notata is a “mantle-species”, because the two highest catches (both over 20%) are in the mantle region. Table1 defines the criteria for qualifying the species according to their spatial distributions. Only 14 species could not be qualified, because they were too rare or their distribution did not fit any of the qualifications defined in Table 1.

Table 1. Types of habitat preferences according to the species distribution patterns exemplified in Fig. 5. The right column shows the number of species attributed to the different types of habitat preferences

True forest species (catches in interior equal to or higher than edge)	3
Canopy species (2 best catches in topmost 2 traps)	3
Mantle species (2 best catches in upper edge traps)	14
Shrub belt species (2 best catches in lower edge traps)	9
Herbaceous fringe species (maximum in herbaceous fringe)	9
Contact zone species (presence in most of the peripheral traps)	7
Ubiquist species (similar presence in most structures)	4
Open land species (maximum catch outside forest)	0
Not classified (too rare or erratic distribution)	14
Total (Neuroptera, Raphidioptera, Mecoptera)	63

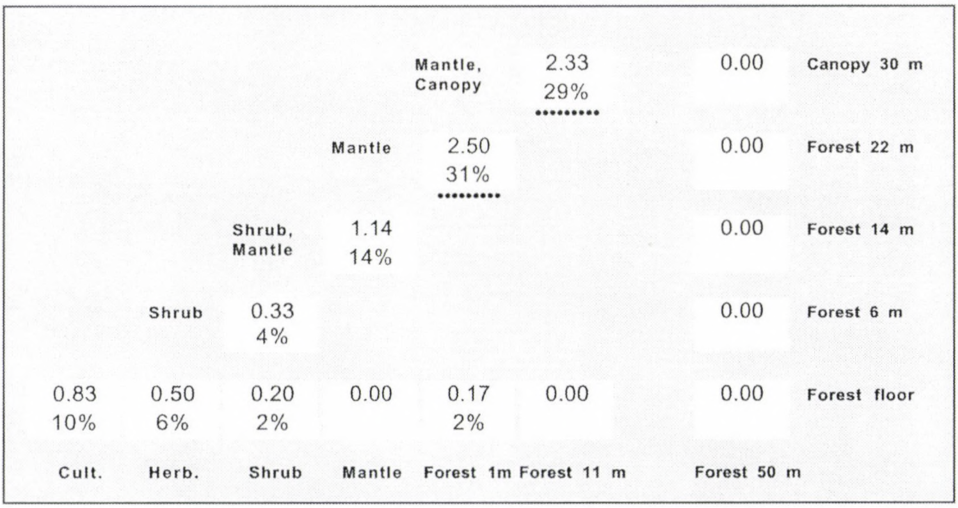


Fig. 5. All information from the various transects condensed into an idealized sloped forest edge: In our example of the snakefly species *Phaeostigma notata*, the upper figures per trap station represent average numbers of individuals collected per trap per year at comparable trap locations of the different forest edge sites. Percentages are given (lower figures) to identify habitat preferences according to criteria listed in Table 1. Underlined are percentages above an arbitrary threshold of 20%. Cult.: cultivated area (meadow, field crop, etc.) with traps 10 m away from the forest edge

Table 1 shows the number of species for the different habitat qualifications and Table 2 shows the habitat preferences for the listed single species. The most striking result is that only three species, *Hypochrysa elegans*, *Hemerobius micans*,

Table 2. List of species collected, with number of specimens per species, habitat preference according to spatial distribution (Fig. 5) and preference criteria defined in Table 1. Flight phenology is shown to the right, where flight peaks are indicated proportionally for species with a total of more than 4 specimens collected. Double squares are peaks for months with more than 33% of the yearly catch, triple squares for catches of more than 66%

Order / Family / Species	Specimens collected	Habitat preference	Phenology: February	March	April	May	June	July	August	September	October	November
Neuroptera												
Coniopterygidae												
Coniopteryx borealis	63	mantle				■	■■	■	■			
Coniopteryx drammonti	2	shrub belt						■				
Coniopteryx esbenpeterseni	13	herb. fringe				■	■■■					
Coniopteryx haematica	1	not class.							■			
Coniopteryx lentiae	24	herb. fringe					■	■■	■■			
Coniopteryx pygmaea	152	shrub belt			■	■■	■	■	■			
Coniopteryx hoelzeli	91	herb. fringe				■	■	■	■■	■		
Coniopteryx tineiformis	200	mantle				■	■	■	■■	■		■
Conwentzia pineticola	5	contact zone						■	■■		■	
Conwentzia psociformis	15	mantle				■	■	■	■■	■		
Helicoconis lutea	32	herb. fringe				■	■■■	■				
Parasemidalis fuscipennis	6	shrub belt					■■	■	■■			
Semidalis aleyrodiformis	7	herb. fringe				■	■■	■	■			
Hemerobiidae												
Drepanepteryx algida	2	not class.					■			■		
Drepanepteryx phalaenoides	4	mantle					■			■		■
Hemerobius atrifrons	2	not class.			■				■			
Hemerobius fenestratus	9	contact zone					■		■■	■■		
Hemerobius gilvus	1	not class.							■			
Hemerobius handschini	4	not class.			■			■	■			
Hemerobius humulinus	282	shrub belt			■	■	■	■	■■	■	■	■
Hemerobius lutescens	8	mantle					■		■	■■		
Hemerobius marginatus	23	ubiquist					■	■	■	■	■	■
Hemerobius micans	261	true forest			■	■	■	■	■	■	■	■
Hemerobius nitidulus	18	mantle			■	■■		■	■■	■	■	
Hemerobius perelegans	3	shrub belt				■	■	■				
Hemerobius pini	163	shrub belt				■	■	■	■■	■	■	■
Hemerobius stigma	20	canopy			■		■	■■	■■	■		
Micromus angulatus	3	herb. fringe						■	■			
Micromus variegatus	10	herb. fringe						■■	■■			

Order / Family / Species	Specimens collected	Habitat preference	Phenology									
			February	March	April	May	June	July	August	September	October	November
Neuroptera												
Hemerobiidae continued												
Sympherobius elegans	11	not class.					▮	■	▮	■		
Sympherobius fuscescens	4	not class.					■	■				
Sympherobius klapaleki	1	not class.							■			
Sympherobius pellucidus	67	ubiquist				■	■	■	▮	■		
Sympherobius pygmaeus	4	mantle					■	■				
Wesmaelius concinnus	18	mantle					■	■	▮	■		
Wesmaelius fassnidgei	1	not class.							■			
Wesmaelius nervosus	7	canopy			■	■			■	■		
Wesmaelius quadrifasciatus	21	shrub belt					■	▮	■			
Wesmaelius subnebulosus	15	contact zone				■	■	▮	■	■		■
Chrysopidae												
Chrysopa dorsalis	1	not class.						■				
Chrysopa pallens	1	not class.							■			
Chrysopa perla	1	not class.						■				
Chrysoperla pallida	602	mantle	■	■	■	■	■	▮	▮	■	■	■
Chrysoperla carnea	250	ubiquist		■	■	■	■	■	▮	■	■	■
Chrysoperla lucasina	98	ubiquist					■	■	▮	■	■	■
Chrysopidia ciliata	57	shrub belt					■	▮	▮			
Cunctochrysa albolineata	62	contact zone				■	■	■	▮	■	■	
Dichochrysa abdominalis	63	mantle					■	■	▮	■		
Dichochrysa flavifrons	167	contact zone						■	▮	■	■	
Dichochrysa prasina	111	contact zone					■	■	▮	■	■	
Dichochrysa ventralis	54	shrub belt					■	▮	▮	■		
Hypochrysa elegans	124	true forest			■	■	▮	■				
Nineta flava	39	canopy					■	▮	▮	■		
Nineta pallida	94	contact zone					■		■	▮	■	
Nineta vittata	1	not class.						■				
Nothochrysa fulviceps	155	true forest					■	▮	▮	■		
Peyerimhoffina gracilis	32	mantle			■	■		■	▮	■	■	
Myrmeleontidae												
Euroleon nostras	1	not class.						■				
Mecoptera												
Panorpidae												
Panorpa communis	910	herb. fringe				■	▮	▮	■	■		
Panorpa germanica	987	herb. fringe				■	■	▮	■	■	■	
Raphidioptera												
Raphidiidae												
Phaeostigma notata	44	mantle				■	▮	■				
Puncha ratzeburgi	11	mantle					■	▮	▮			
Venustoraphidia nigricollis	23	mantle					▮	▮	■			

and to a lesser degree *Nothochrysa fulviceps*, are truly species of the forest interior. On the other hand, no species was found preferentially outside the forest, and even the four species considered being "ubiquists" have a stronghold in the forest edge.

The species charts shown in Figs 2–4 can also be displayed at weekly or monthly intervals. Species distributions in both space and time cannot be shown here, but some indication on adult flight phenologies is given in Table 2.

For the newly (re-) detected sibling species of the *Chrysoperla carnea* group, the spatial distributions in winter and summer are of particular interest. *Chrysoperla lucasina* (HENRY *et al.* 1996) and *C. carnea* (HENRY *et al.* 2002; Cc4 sensu DUELLI *et al.* 1996, "*C. kolthoffi*" sensu LERAUT 1991) were both most frequent outside the forest in spring and summer, while in autumn and late winter they were mainly collected in the uppermost traps of the forest edges. In autumn, *C. carnea* was also trapped in large numbers in the canopy layer of the forest interior. *C. pallida* (Cc2 sensu DUELLI *et al.* 1996, "*C. carnea*" sensu LERAUT) seems to be strictly arboreal, with a preference for the forest edges all year round. Only few specimens were collected outside the forest. In autumn and late winter, equal numbers of *C. pallida* were collected in the interior forest and in the edges.

DISCUSSION

Neuroptera and Raphidioptera are generally considered to be mainly arboreal (ASPÖCK *et al.* 1980), while the Mecoptera are far less associated with forested areas. So the question "what is a real forest species?" is particularly pertinent for the Neuroptera and Raphidioptera. A species here is considered to be arboreal if it depends to a large degree (e.g. for some period during its lifetime) on the presence of trees. But that does not necessarily mean that it is a forest species. We can distinguish "true forest species", which depend to some degree on the presence of forests. Without closed stands of trees covering a certain area, that species would not be there at all. Additionally, there are "facultative forest species", which can live in forests, but also in areas with scattered single trees, or groups of trees. They do not depend on closed forest stands, and therefore the size of a forest area is not of crucial importance to their existence. Furthermore, of course, there are species, which do not even depend on the presence of trees.

Nature conservation often deplores the fragmentation of managed forests, because fragmentation is seen as a major cause for the loss of biodiversity.

Our aim was to search for exactly the kind of species that are threatened by extinction when forest areas are diminished or fragmented. Island biogeography theory (MACARTHUR & WILSON 1967) predicts, that with diminishing area of a

habitat island, the species number of habitat specialists will diminish too (MADER 1983). Many Neuroptera and Raphidioptera are undoubtedly habitat specialists in forested areas. Are they threatened by fragmentation of forests?

To answer that question, we had to find out their habitat preferences in forested areas. Are they forest specialists, i.e. more common in forests than outside? To be threatened by fragmentation of forest areas, a species has to be a "true forest species", which prefers the forest interior to the forest edges. Ecotone species, which are habitat specialists for forest-edge structures, such as the forest mantle, the shrub belt or even the herbaceous fringe (which is considered here to be an important ecotone structure of forests), may depend on the presence of forests, but do not vitally depend on the forest interior, and thereby will not make use of a larger forest area.

Table 1 and 2 clearly show that only a small minority of three species (5%) were collected inside the forest at equal or higher numbers than at the forest edges. For all other species (95%) we can assume that the size of the forest interior does not really matter much, as long as their preferred habitat within the forest edge is intact. Since we also collected very early and late in the season, we can exclude that some of these ecotone species depend on the forest interior for hibernating. The observed movement of the *Chrysoperla* species (which hibernate as adults) from the edge to the interior in late autumn hardly reached the tower site at a distance of 50 m to the forest edge.

These findings for two insect orders, notorious for depending on forests, open up the question on how generally applicable our hypotheses is, that most forest species in managed forests in fact are forest edge species. In Danish beech forests, species diversity of vascular plants was negatively correlated with forest area (LAWESSON *et al.* 1998). But the authors identified some habitat specialists for the forest interior, which they interpret as specialists for ancient forests. Continuity of forest cover seems to be more important than forest size. In our neuropteran sample of only three true forest specialists, none of them is known to be dependent on ancient forests.

Several published records show that within the interior of managed forests the number of arthropod species and individuals collected is higher in the canopy than on the ground or in between (STORK *et al.* 1997) . That is consistent with our findings for the Neuroptera, but neglects the fact that there are even more species, and individuals of these species, in the ecotone structures at the forest edge, than in the canopy.

Only few publications deal with the spatial distribution of Neuroptera, Raphidioptera, or Mecoptera in forests, and particularly in forest edges. Canopy Neuroptera were collected in various forests in Poland by (CZECHOWSKA 1994), but

there was no comparison with other forest structures. SAURE and KIELHORN (1993) collected Neuroptera on oaks and Scots pine in urban forests of Berlin. After correcting their figures for collecting effort, two-thirds of the species on oaks were collected in higher numbers at 15 m height than at 5 m. In our samples in beech forest, all species collected in the forest interior increased with height. But at the forest edges, most Coniopterygidae were preferentially in the herbaceous and shrub layer, most Hemerobiidae at intermediate heights in the shrub or mantle layer, and the Chrysopidae had their maxima in the upper mantle layer.

SAURE and KIELHORN (1993) identified *Sympherobius klapaleki* as a canopy species on oak. We only collected one specimen, and it also was found in the canopy layer of a mixed beech forest with scattered oaks. The flight phenologies given by SAURE and KIELHORN (1993) largely coincide with ours, but in general the species in Switzerland started out three weeks later, which is likely to be due to an elevation of 460–620 m in Switzerland, instead of less than 100 m at Berlin.

Of particular interest was the distribution of the three sibling *Chrysoperla* species in space and time. THIERRY *et al.* (1995) investigated the hibernation sites of all three species in central France. The evergreen *C. lucasina* was only found in ivy tufts, *C. carnea* (called "*C. kolthoffi*"), with colour change, mostly in buildings, but in late winter together with *C. pallida* (called "*C. carnea*") in dry leaves and ivy tufts. The results of our trap catches show that both *C. lucasina* and *C. carnea* enter the forest ecotone structures in autumn and stay there until next spring. While hibernating *C. lucasina* were only collected in traps in the forest edge, *C. carnea* also was found in large numbers in the canopy of the forest interior. We suspect that these individuals were caught in transit over the forest. *C. pallida* was by far the most abundant neuropteran insect in the forest edges all year round. In autumn and late winter, relatively more specimens were collected in the forest interior than in spring and summer, indicating a slight population movement in that species also – from the edges towards the interior.

*

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LIST OF THE NAME-BEARING NEUROPTERIDA TYPES IN THE COLLECTION OF THE NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION, USA

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The collection of Neuropterida at the National Museum of Natural History, Smithsonian Institution, is housed in 221 insect drawers and 311 bottles of vials. It is estimated to contain 132 species of Megaloptera, 1192 species of Neuroptera and 33 species of Raphidioptera. The 163 name-bearing types are divided among the Megaloptera (26), Neuroptera (134), and Raphidioptera (3). A list of all the name-bearing types including author, year of publication, country of origin, and current placement is given; it is also noted if it is a lectotype or neotype.

Key words: Neuroptera, Megaloptera, Raphidioptera, name-bearing types, Smithsonian Institution

HISTORICAL REVIEW

A National Museum was established by the U.S. Government in 1842, four years before the founding in 1846 of the Smithsonian Institution, which soon absorbed the National Museum. Entomological work in agriculture for the government was carried on in the Patent Office prior to the establishment in 1862 of the Department of Agriculture wherein a position of Entomologist was specified (WARD 1976). C. V. RILEY and J. H. COMSTOCK served as early heads of Entomology in Agriculture and developed the first insect collections. The National Insect Collection was initiated in 1881 when RILEY, chief entomologist of the Department of Agriculture, was appointed honorary (i.e. unpaid) Curator of Insects at the Smithsonian Institution. He took this position very seriously and worked to establish a salaried position of Assistant Curator. As soon as he was successful he turned over his personal collection of some 150 000 insects (20 000 species) to the Institution and arranged the transfer of the Agriculture collection to the Museum. In 1894 the first Museum Aid appointed in the Museum was ROLLA P. CURRIE, a "Neuropterist" in the classical sense. He, with his sister BERTHA P. CURRIE, began to form a collection of international scope.

CURRIE published ten papers on Neuroptera and another five on Odonata between 1898 and 1918. In them he described one genus and 17 species and varieties of antlions (Myrmeleontidae) and 7 species of brown lacewings (Hemerobiidae).

The types of these species provided the nucleus of the Neuroptera collection in the National Museum. In addition, he spent 10 weeks in the summer of 1903 collecting insects in the company of H. G. DYAR and A. N. CAUDELL in the Kootenay District of British Columbia, and wrote a most interesting account of this trip (CURRIE 1904). In 1904 CURRIE transferred to the Department of Agriculture where he soon was placed in charge of their editorial office. He retired in 1945 at the age of 70, but started a new career, studying for, and being ordained as, a priest in the Episcopal Church. He died in 1960 in his 86th year (EDMUNDS & MUESEBECK 1961).

Between 1904 and 1916 NATHAN BANKS served as research taxonomist on insects and arachnids for the Department of Agriculture. Although his personal collection all went to Harvard University, there are some types and many determined specimens in the National Collection bearing BANK's labels (CARPENTER & DARLINGTON 1954).

After BANKS departure there was no specialist on the Neuropteroid orders in the Museum, what work was done was accomplished by the resident Orthopteroid specialists. Both A. N. CAUDELL and A. B. GURNEY took an interest in the order and published papers on various families. In 1944 SOPHY I. PARFIN was hired by the Smithsonian to care for the various smaller insect orders. She published a number of papers, the most noted being the revision of the spongilla flies (Sisyridae) coauthored with GURNEY (GURNEY & WALKLEY 1967). After she retired in late 1960, I was hired to fill the same position and to curate and do research on the smaller insect orders, especially the "Neuropteroids". Although my research has been primarily on the caddisflies (Trichoptera) I have done a bit with the aquatic neuropteroids, and have been responsible for their curation.

THE COLLECTION

The collection of Neuropterida is mostly pinned and stored in unit trays in large, glass-topped insect drawers. Some material is in alcohol, mostly the immature stages, but some adults also are kept this way. The entire collection occupies 221 drawers (42 Megaloptera, 175 Neuroptera, 4 Raphidioptera), and 311 bottles (100 Megaloptera, 206 Neuroptera, 5 Raphidioptera) each with up to 20 internal vials of specimens. In terms of number of species, a quick count (not including unidentified material) gave 132 species of Megaloptera, 1192 of Neuroptera, and 33 of Raphidioptera.

We have material from all over the world, but our holdings are most complete for North America. There have been no major private collections donated to us, but we have received some valuable material from outside donors. A synoptic collec-

tion was donated by the Kenya Museum, W. R. B. HYND has given synoptic collections of European species, and WARO NAKAHARA donated a synoptic collection of Japanese Neuroptera. Much material was collected for the Museum by the missionary D. C. GRAHAM in Sechuan, China and adjacent regions. Most of the material has slowly aggregated from countless small lots from many sources. In recent years extensive field work by staff members of the Museum has added much material, especially from the Neotropical Realm.

NAME-BEARING TYPES

The name-bearing types are segregated from the main collection, each one being its own unit tray in glass-topped museum drawers, or in bottles for the alcoholic examples. After the preliminary list was prepared all the names were checked against the original descriptions for authenticity, and then the specimens were located in the type collection to ensure accuracy. In the process some 6 more types were located, but another 4 that were syntypes were demoted, because lectotypes had been designated from other collections. I am now able to verify 163 name-bearing types – 26 Megaloptera, 134 Neuroptera, and 3 Raphidioptera

The species are listed alphabetically by family, in their original combinations and spelling. The author, date of publication, and country (and state in the USA) of origin are given. The current generic placement or specific synonymy is given when there has been a change from the original status. It is noted if the specimen is a neotype or lectotype.

MEGALOPTERA

Family Corydalidae

Archichauliodes pinares FLINT , 1973; Chile.
Chauliodes angusticollis HAGEN 1861; USA, Georgia; neotype; now in *Neohermes*.
Chloronia absona FLINT , 1992; Costa Rica.
Chloronia antilliensis FLINT , 1970; Dominica.
Chloronia gloriosoi PENNY et FLINT , 1982; Panama.
Chloronia mirifica NAVÁS, 1925; Costa Rica; neotype.
Corydalus arpi NAVÁS, 1936; Venezuela; neotype.
Corydalus australis CONTRERAS-RAMOS, 1998; Argentina.

Corydalus flinti CONTRERAS-RAMOS, 1998; Venezuela.
Corydalus imperiosus CONTRERAS-RAMOS, 1998; Argentina.
Corydalus longicornis CONTRERAS-RAMOS, 1998; Bolivia.
Corydalus neblinensis CONTRERAS-RAMOS, 1998; Venezuela.
Neohermes infuscatus CAUDELL, 1933; USA, California; jr. syn. of *Protochauliodes minimus* (DAVIS).
Neohermes matheri FLINT, 1965; USA, Mississippi.
Neuromus pallidus DAVIS, 1903; Mexico; now in *Chloronia*.
Nothochauliodes penai FLINT, 1983; Chile.
Platyneuromus soror var. *honduranus* NAVÁS, 1928; Honduras; neotype; now *Platyneuromus honduranus* NAVÁS.
Platyneuromus reflexus GLORIOSO et FLINT, 1984; Mexico.
Protochauliodes bullocki FLINT, 1973; Chile.
Protochauliodes cinerascens fumipennis FLINT, 1973; Chile.

Family Sialidae

Sialis contigua FLINT, 1964; USA, Virginia.
Sialis dreisbachi FLINT, 1964; USA, Michigan.
Sialis nevadensis DAVIS, 1903; USA, Nevada.
Sialis nina TOWNSEND, 1939; USA, Kentucky.
Sialis sinensis BANKS, 1940; China.
Sialis spangleri FLINT, 1964; USA, Maryland.

NEUROPTERA

Family Ascalaphidae

Stephanolasca alfierii NAVÁS, 1925; Egypt; lectotype; jr. syn. of *Bubopsis hamata* (KLUG), det. TJEDER.
Tytomyia flinti TJEDER et HANSSON, 1992; Senegal.

Family Berothidae

Nodalla aegyptiaca NAVÁS, 1926; Egypt; jr. syn. of *Nodalla (Nodalla) saharica* (ESBEN-PETERSEN), det. ASPÖCK.

Podallea tjederi U. ASPÖCK et H. ASPÖCK, 1981; Nigeria.
Spiroberotha sanctarosae ADAMS, 1990; Costa Rica.

Family Chrysopidae

Allochrysa titan BANKS, 1915; Costa Rica; now in *Nacarina*.
Chrysopa adoina BANKS, 1946; Mexico; jr. syn. of *Ceraeochrysa claveri* NAVÁS.
Chrysopa alethes BANKS, 1940; China.
Chrysopa alfierii NAVÁS, 1926; Egypt; lectotype; now in *Brinckochrysa*.
Chrysopa californica COQUILLETT, 1890; USA, California; jr. syn. of *Chrysoperla plorabunda* (FITCH).
Chrysopa chione BANKS, 1940; China; now in *Retipenna*.
Chrysopa fratercula BANKS, 1940; China.
Chrysopa grahami BANKS, 1940; China; now in *Retipenna*.
Chrysopa schwarzi BANKS, 1903; USA, New Mexico; now in *Meleoma*.
Chrysopa signatalis BANKS, 1911; USA, Texas; jr. syn. of *Chrysopodes (Neosuarius) collaris* (SCHNEIDER).
Dichochrysa setosa HÖLZEL et OHM, 1995; Madagascar.
Hypochrysa viridula ADAMS, 1978; Argentina.
Italochrysa madagassa HÖLZEL et OHM, 1995; Madagascar.
Leucochrysa cinctipes BANKS, 1915; Panama; now in *Berchmansus*.
Mallada (Triadochrysa) triangularis ADAMS, 1978; Mexico.
Meleoma macleodi TAUBER, 1969; Mexico.
Meleoma pipai TAUBER, 1969; Mexico.
Nodita panamana BANKS, 1944; Panama; now in *Leucochrysa (Nodita)*.

Family Coniopterygidae

Aleuropteryx arceuthobii MEINANDER, 1975; USA, Colorado.
Aleuropteryx vulgaris MEINANDER, 1972; USA, Texas.
Bidesmida morrisoni JOHNSON, 1977; USA, New Mexico.
Coniopteryx angusta BANKS, 1906; USA, Arizona; now in *Semidalis*.
Coniopteryx (Scotoconiopteryx) biapicata MEINANDER, 1983; Uruguay.
Coniopteryx (Coniopteryx) ceylonica MEINANDER, 1982; Sri Lanka.
Coniopteryx (Xeroconiopteryx) diversicornis MEINANDER, 1972; USA, Texas.
Coniopteryx (Coniopteryx) dominicana MEINANDER, 1974; Dominica.
Coniopteryx (Scotoconiopteryx) flinti MEINANDER, 1975; Mexico.

Coniopteryx (Coniopteryx) freytagorum JOHNSON, 1978; Honduras.
Coniopteryx (Scotoconiopteryx) fumicolor MEINANDER, 1972; Costa Rica.
Coniopteryx (Scotoconiopteryx) isthmicola MEINANDER, 1972; Panama.
Coniopteryx (Xeroconiopteryx) laticornis MEINANDER, 1972; Australia.
Coniopteryx (Xeroconiopteryx) latilobus MEINANDER, 1975; South Africa.
Coniopteryx (Xeroconiopteryx) latistylus MEINANDER, 1982; Sri Lanka.
Coniopteryx (Coniopteryx) macroscapes MEINANDER, 1990; Malaysia, Sabah.
Coniopteryx (Coniopteryx) morobensis MEINANDER, 1990; Papua New Guinea.
Coniopteryx (Coniopteryx) palpalis MEINANDER, 1972; Mexico.
Coniopteryx (Coniopteryx) papuensis MEINANDER, 1990; Papua New Guinea.
Coniopteryx (Coniopteryx) simplicior MEINANDER, 1972; USA, Texas.
Coniopteryx (Xeroconiopteryx) squamata MEINANDER, 1983; South Africa.
Coniopteryx (Xeroconiopteryx) texana MEINANDER, 1972; USA, Texas.
Coniopteryx (Xeroconiopteryx) virgina MEINANDER, 1990; U.S. Virgin Islands, St. John.
Heteroconis papuaensis MEINANDER, 1990; Papua New Guinea.
Incasemidalis chilensis MEINANDER, 1990; Chile.
Neoconis bispina MEINANDER, 1972; U.S. Virgin Islands, St. Thomas.
Neoconis dentata MEINANDER, 1972; Guatemala.
Neoconis inexpectata MEINANDER, 1972; USA, Arizona.
Neoconis marginata MEINANDER, 1972; USA, Texas.
Neoconis unicornis MEINANDER, 1990; Colombia.
Neosemidalis (Neosemidalis) brevipennis MEINANDER, 1990; Papua New Guinea.
Neosemidalis (Leucosemidalis) furcifera MEINANDER, 1972; Australia.
Pampoconis insulana MEINANDER, 1974; Jamaica; now in *Neoconis*.
Pseudoconis maculipennis MEINANDER, 1972; South Africa.
Semidalis brasiliensis MEINANDER, 1974; Brazil.
Semidalis ecuadoriana MEINANDER, 1983; Ecuador.
Semidalis flinti MEINANDER, 1972; USA, Texas.
Semidalis hidalgoana MEINANDER, 1975; Mexico.
Semidalis inconspicua MEINANDER, 1972; USA, Virginia.

Family Hemerobiidae

Adelphohemerobius enigmaramus OSWALD, 1994; Chile.
Allemerobius flaveolus BANKS, 1940; China; now in *Hemerobius*.
Annandalia irregularis CARPENTER, 1961; Caroline Islands, Truk; now in *Psectra*.
Annandalia maculosa CARPENTER, 1961; Palau Islands, Babelthaup, now in *Psectra*.

Austromegalomus insulanus OSWALD, 1988; French Polynesia, Austral Islands, Rapa.

Hemerobius barberi BANKS, 1903; USA, Arizona; now in *Sympherobius*.

Hemerobius bispinus BANKS, 1940; China.

Hemerobius bistrigatus CURRIE, 1904; USA, California.

Hemerobius caudelli CURRIE, 1904; Canada; jr. syn. of *Hemerobius conjunctus* FITCH.

Hemerobius chiangi BANKS, 1940; China.

Hemerobius chilensis Nakahara 1965; Chile.

Hemerobius dyari CURRIE, 1904; Canada; jr. syn. of *Hemerobius stigma* STEPHENS.

Hemerobius exceptatus NAKAHARA, 1965; Colombia.

Hemerobius glacialis CURRIE, 1904; Canada; jr. syn. of *Hemerobius conjunctus* FITCH.

Hemerobius grahami BANKS, 1940; China.

Hemerobius kokaneeanus CURRIE, 1904; Canada.

Hemerobius kootenayensis CURRIE, 1904; Canada; jr. syn. of *Hemerobius pinidumus* FITCH.

Hemerobius neadelphus GURNEY, 1948; Canada.

Hemerobius nekoi MONSERRAT 1996; Chile.

Hemerobius pallescens CURRIE, 1904; USA, California; jr. syn. of *Hemerobius pacificus* BANKS.

Hemerobius schwarzi BANKS, 1903; USA, Arizona; now in *Wesmaelius*.

Hemerobius solidarius MONSERRAT 1996; Colombia.

Hemerobius umbratus BANKS, 1903; USA, Arizona; now in *Sympherobius*.

Kimminsia alexanderi NAKAHARA, 1965; USA, Alaska; jr. syn. of *Wesmaelius nervosus* (FABRICIUS).

Kimminsia constricta PARFIN, 1956; USA, Alaska; now in *Wesmaelius*.

Kimminsia melaleuca NAKAHARA, 1965; Canada; jr. syn. of *Wesmaelius nervosus* (FABRICIUS).

Kimminsia olympica NAKAHARA, 1965; USA, Washington; jr. syn. of *Wesmaelius constrictus* (PARFIN).

Megalomus latus BANKS, 1903; USA, Arizona; jr. syn. of *Megalomus moestus* BANKS.

Neuronema similis BANKS, 1940; China.

Nomerobius cuspidatus OSWALD, 1988; Argentina.

Spinomegalomus flinti NAKAHARA, 1965; Chile; now in *Megalomus*.

Sympherobius texanus NAKAHARA, 1965; USA, Texas; jr. syn. of *Sympherobius arizonicus* BANKS.

Family Myrmeleontidae

Araucaleon inca BANKS, 1938; Bolivia.

Brachynemurus barberi CURRIE, 1903; USA, Arizona; now in *Gnopholeon*.

Brachynemurus brunneus CURRIE, 1898; USA, Wyoming; jr. syn. of *Brachynemurus ferox* (WALKER).

Brachynemurus coquilletti CURRIE, 1898; USA, Arizona; now in *Clathroneuria*.

Brachynemurus curriei MCCLENDON, 1906; USA, Texas; jr. syn. of *Abatoleon dorsalis* (BANKS).

Brachynemurus delicatulus CURRIE, 1903; USA, Arizona; now in *Gnopholeon*.

Brachynemurus hubbardii CURRIE, 1898; USA, Arizona; lectotype.

Brachynemurus hubbardii var. *nubeculipennis* CURRIE, 1903; USA, Arizona; lectotype; syn. of *Brachynemurus hubbardii*.

Brachynemurus intermedius CURRIE, 1903; USA, Arizona; now in *Scotoleon*.

Brachynemurus irregularis CURRIE, 1906; USA, Texas.

Brachynemurus niger CURRIE, 1898; USA, Arizona; now in *Scotoleon*.

Brachynemurus papago CURRIE, 1899; USA, Arizona; now in *Mexoleon*.

Brachynemurus pusillus CURRIE, 1899; USA, New Mexico; lectotype; now in *Chaetoleon*.

Brachynemurus quadripunctatus CURRIE, 1898; USA, California; now in *Scotoleon*.

Brachynemurus schwarzi CURRIE, 1903; USA, Arizona; now in *Clathroneuria*.

Brachynemurus singularis CURRIE, 1903; USA, Arizona; now in *Scotoleon*.

Brachynemurus yavapai CURRIE, 1903; USA, Arizona; now in *Scotoleon*.

Capophanes conspersa BANKS, 1938; S.W. Africa (now Namibia).

Dendroleon insolita BANKS, 1940; China; now in *Bullanga*.

Distoleon boninensis ADAMS, 1959; Chichi Jima, Bonin Islands, Japan.

Epacanthaclisis banksi KRIVOKHATSKY, 1998; China.

Indophanes sinensis BANKS, 1940; China.

Mossega waidoraensis NEW, 1990; Papua New Guinea.

Myrmeleon immaculatus var. *occidentalis* CURRIE, 1903; USA, Arizona; jr. syn. of *Myrmeleon exitialis* WALKER.

Myrmenemurus clavatus NAVÁS, 1926; Egypt; lectotype; jr. syn. of *Mesonemurus harterti* NAVÁS.

Psammoleon sinuatus CURRIE, 1903; USA, Arizona.

Family Nymphidae

Osmylops nesos OSWALD, 1998; Papua New Guinea.

Family Osmylidae

Kempynus digoniostigma OSWALD, 1994; Chile.
Kempynus tjederi OSWALD, 1994; Chile.
Osmylus taiwanensis NEW, 1991; Taiwan.

Family Sisyridae

Climacia chapini PARFIN et GURNEY, 1956; USA, Texas.
Climacia chilena PARFIN et GURNEY, 1956; Chile.
Climacia doradensis FLINT, 1998; Venezuela.
Climacia insolita FLINT, 1998; Argentina.
Climacia lemniscata FLINT, 1998; Argentina.
Climacia striata PARFIN et GURNEY, 1956; Panama.
Climacia triplehorni FLINT, 1998; Argentina.
Climacia versicolor FLINT, 1998; Argentina.
Sisyra panama PARFIN et GURNEY, 1956; Panama.
Sisyra trilobata Flint 1966; Israel.

RAPHIDIOPTERA

Family Raphidiidae

Agulla (Agulla) modesta CARPENTER, 1936; USA, Utah; now *Agulla (Glavia) modesta modesta* CARPENTER.
Agulla (Agulla) neglecta CARPENTER, 1936; USA, California; jr. syn. of *Agulla (Agulla) bractea* CARPENTER.
Raphidia minuta BANKS, 1903; USA, Arizona; now in *Alena* (*Aztecoraphidia*).

*

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ANTLION ASSEMBLAGES (NEUROPTERA: MYRMELEONTIDAE) OF TWO ARID HABITATS IN TUNISIA

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The antlion fauna was investigated by black-lighting in late spring and late summer at two sites in southern Tunisia, representing pre-Saharan acacia savanna and dwarf shrub semi-desert of the Sahara, respectively. The species compositions recorded differed very markedly between sites and seasons, with few species encountered in both habitats or in both collecting periods. Diversity was distinctly lower at the semi-desert site, where only 21 species, but a high number of individuals, were caught, with a strong dominance of one species each in the two seasons. At the acacia savanna location, 26 species were found, a few of which may, however, be associated with adjoining biotopes of oasis vegetation, ravines and hillside grassland. The species assemblage of the savanna is compared to a previous, similarly rich sample from the same region. Some taxonomic and faunistic remarks are given regarding the species collected.

Key words: Myrmeleontidae, North Africa, habitat preferences, phenology, systematics

INTRODUCTION

Knowledge of the North African antlion fauna is still very incomplete, compared to other regions of the Palaearctic eremial. For the Middle East and Arabia, HÖLZEL (1972, 1981, 1982, 1983, 1988) has provided thorough revisions of the family Myrmeleontidae. KRIVOKHATSKY (*e.g.* 1990, 1992, 1994, 1996, also KRIVOKHATSKY & ZAKHARENKO 1994) has extensively investigated the myrmeleontid fauna of Central Asian deserts, and those of Mongolia are well known through the works of HÖLZEL (1970*a, b*) and KRIVOKHATSKY *et al.* (1996). When attempting to identify North African myrmeleontids, though, we as yet still depend on the insufficient and highly scattered information from numerous works by NAVÁS (1921*a, b*, 1928, 1930, 1931, 1933, 1934, 1936 and many others). The species hitherto reported from North Africa have recently been catalogued (ASPÖCK & HÖLZEL 1996, ASPÖCK *et al.* 2001).

While research on European Myrmeleontidae now comprises several works on reproductive biology (*e.g.* YASSERI 1994, YASSERI & PARZEFALL 1996, YASSERI *et al.* 1998), adult and larval feeding (*e.g.* STELZL & GEPP 1990, LACKINGER 1973) and habitat choice (*e.g.* STEFFAN 1971, YASSERI *et al.* 1997), work on Palaearctic eremial antlions has hitherto been virtually exclusively taxonomic. Information on ecology and phenology is present within the collection data in taxo-

nomic and faunistic publications but these have mostly not been analysed. KRIVOKHATSKY *et al.* (1996) give an overview of habitat preferences for Mongolian Myrmeleontidae, and KRIVOKHATSKY (1998) summarizes data on seasonality at the generic level for the Palearctic. The study of collection data is impeded by the fact that most material (with the exception of much of that dealt with by the latter author) was usually not collected by the specialists themselves.

During two recent visits to southern Tunisia, I was able to collect numerous Myrmeleontidae, mainly by light-trapping. The two sites investigated during these trips represent distinctly different habitats within the Maghrebinian arid zone, namely remnants of acacia savanna on one hand and an ecotone of dwarf shrub semi-desert and erg (sandy desert) on the other. The excursions took place in August/September 1998 and in May/June 1999, so that information on the seasonal occurrence of species could be obtained. Coincidentally, the only comparatively large sample of antlions hitherto collected in Northern Africa originates from the immediate vicinity of the savanna site newly investigated. This material, procured by C. DUMONT in 1927, thus enables an interesting comparison with the recent sample, especially as information on the month of collecting accompanies the specimens.

The material gathered also gives new insights on numerous taxonomic questions regarding the Myrmeleontidae of North Africa. However, a full revision that can assign valid names to all species reported here will depend on the reinvestigation of all historic material, particularly all extant NAVÁS types.

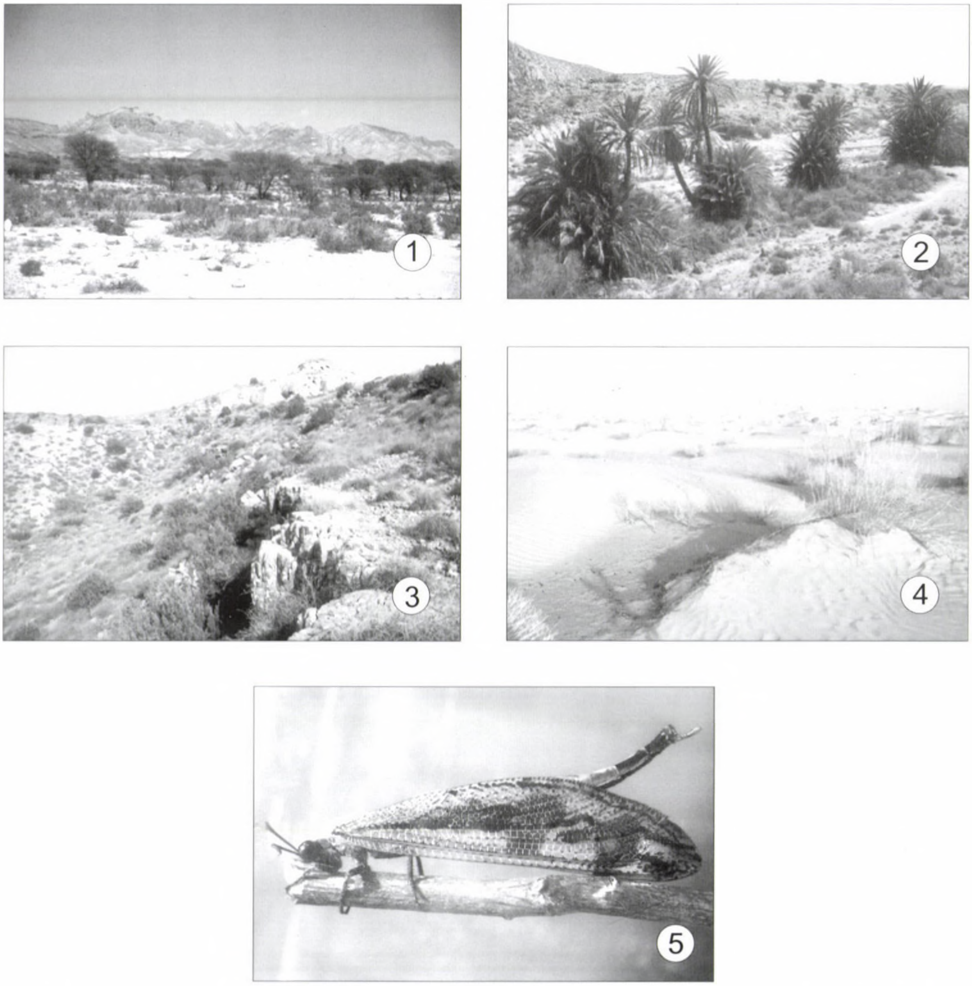
MATERIAL AND METHODS

Localities

Collecting took place at two sites, both declared Tunisian national parks. Bou Hedma National Park (about 34°29'N 9°39'E, currently 116 km²) is the oldest protected area existing in Tunisia, a forest reserve since 1936, incorporating the only considerable remnant of acacia savanna still extant in the country (Fig. 1). Elsewhere, acacia (*Acacia raddiana* (SAVI) BRENAN) had been removed virtually completely by the end of the 19th century, and natural vegetation communities have undergone further heavy degradation, mainly by grazing. With an annual precipitation of about 250 mm, Bou Hedma is situated near the dry limit for the growth of acacia trees. Since about 1985, Bou Hedma National Park has focused on the establishment of semi-wild stocks of bovid species (*e.g. Addax nasomaculatus* (DE BLAINVILLE, 1816) and *Oryx dammah* (CRETZSCHMAR, 1827)) and of ostrich (*Struthio camelus* LINNAEUS, 1758), all native to this part of North Africa but extinct there since the 19th century. Besides savanna plain with acacia trees, the Bou Hedma mountain chain adjoining to the north, with peaks up to about 800 m elevation is also incorporated in the park (Figs 1, 3).

Along the northern border of the Grand Erg Oriental in southern Tunisia, about 50 km south of the oasis of Douz, a section which is not subject to any specific landuse has been recently set aside as

the Jbil National Park (around 33°N 9°E; a more commonly encountered transcription is "Djebil"). It incorporates the northern rim of the Sahara sandy desert (erg) as well as adjoining semi-desert of chamaephytes and perennial grasses (Fig. 4). Here, annual precipitation is distinctly below 100 mm which is often given as the defining border of the Sahara. The national park is projected to eventually cover about 1500 km^2, but details on its precise extension are not currently available from Tunisian authorities.



Figs 1–5. 1 = *Acacia* savanna at Bou Hedma National Park with the Bou Hedma range in the background. 2 = Oasis vegetation adjoining a brook (nearly dry in summer) at the foot of the Bou Hedma mountains. 3 = Open stand of juniper at about 500 m elevation in the Bou Hedma chain. 4 = Dwarf shrub semi-desert with grass tussocks at the border of the Grand Erg Oriental in the Jbil region. 5 = "*Palpares*" *germaini* male at Jbil

Black-lighting

For the collection of adult antlions, a light-trap of commonly used design was employed, consisting of a metal frame carrying a cylindrical piece of transparent drapery cloth surrounding the light source at its center. A mixed light fluorescent lamp with strong UV emission (20 W) was used, accompanied by a pure ultraviolet light (18 W) during the 1999 trip. Usually all Myrmeleontidae settling on the trap or flying in the vicinity were collected. In a few instances, numbers of very abundant species attracted on a particular evening were estimated and not all specimens taken. Wind conditions permitting, the light-trap was usually operated from around sunset (about 19h20 local time in late spring, shortly after 20h00 in late summer) until numbers of antlions newly attracted dropped noticeably. This happened consistently between 0h30 and 1h30, if winds remained low throughout.

In the acacia savanna and the dwarf shrub semi-desert, 4 stations each were selected to carry out black-lighting. No significant differences between these were apparent within the very uniform habitat at Jbil – this was confirmed by the catch results – even though the maximum distance between two of them was about 15 km. Only one of these 4 locations was visited during the second investigation period in spring 1999. At Bou Hedma, in contrast, the 4 stations within a radius of only 2 km represented two distinctly different kinds of biotopes. While two stations were in open savanna, the two northerly ones were situated at the foot of the mountain range, adjacent to two clumps of oasis vegetation. These were supported by a watercourse descending from the mountains to the savanna plain (Fig. 2) and by an artificial catchment from a source on the lower slopes, respectively.

In Table 1, the successful trapping days (defined as producing at least 10 specimens) are listed with some temperature data. The climate was generally slightly cooler in May/June than in August/September, except for one day (02.06.) at the semi-desert site. Early September 1998 at Bou Hedma was characterized by exceptionally high humidity. In complement to the samples from late spring and late summer, other workers have procured some specimens, using the same kind of light trap in autumn 1999 both at Bou Hedma (05–07.10.) and at Jbil (11–15.10.), and at hand-held oil-lamps in early spring 2001 at Jbil (03.04.).

Table 1. Dates of light-trapping in Tunisia with indication of temperature ranges for the day and during black-lighting sessions

sites	1998 trapping dates	20h00 (top) and 1h00 (bottom) temp.	daily max. (top) and min. (bottom) temp.	1999 trapping dates	19h30 (top) and 1h00 (bottom) temp.	daily max. (top) and min. (bottom) temp.
Bou Hedma	21–24.08.	29–31°C	40–42°C	25–26.05.	21–24°C	39°C
(savanna stations)		22–27°C	20–22°C		18–20°C	17–18°C
Jbil	26–27.08.	31–38°C	45–49°C	30.05.–02.06.	31–38°C	42–44°C
(semi-desert /erg)	31.08.–02.09.	24–31°C	19–21°C		25–31°C	19–23°C
Bou Hedma	04–06.09.	34°C	39–40°C	06.06.	29°C	40°C
(oasis stations)		27–29°C	24°C		24°C	21°C

Other collecting methods

Antlions were also occasionally found during the day, flying actively, or when beating vegetation. These, however amounted to less than 4% of the specimens from Bou Hedma, while at Jbil only 1 individual was thus detected. Numerous larvae of pit-building species were collected at Bou Hedma and some later raised. These are not included in the numeric totals given in the results section. The quest for non-pit-building larvae unfortunately proved largely futile at the investigated localities.

Historic samples

In the late 1920s, C. DUMONT collected a variety of insects in south-central Tunisia, among these a large number of Myrmeleontidae. The latter were treated mainly by NAVÁS (1930), with additions and repetitions in NAVÁS (1931, 1933, 1934, 1936). As NAVÁS' concepts regarding species delimitation and denomination are very insufficient, it has been necessary to reinvestigate DUMONT's material, preserved chiefly at the Museum National d'Histoire Naturelle, Paris (MNHN), in order to gain a data set suitable for comparison to the present sample from Bou Hedma. At MNHN, a total of 458 specimens of Myrmeleontidae labeled "Maknassy 1927" were investigated, with additional indication of the month of collecting (between May and August) for 446 of them. The town of Maknassy is situated north of the Bou Hedma range, a direct distance of less than 15 km from Bou Hedma NP. Some further specimens belonging to this series have been seen in the Naturhistorisches Museum Basel (NHMB) and further ones may be present in other museums. There are, in MNHN, additional Myrmeleontidae collected by DUMONT labeled "Maknassy 1929" (June to November, 105 specimens) and "Bou Hedma 1929" (May and June, 43 specimens). Only a few specimens of the latter series have been published by NAVÁS (1931, 1933, 1934). These samples are not evaluated specifically in the present paper though some reference is made in the following as concerns species of interest not present among the "Maknassy 1927" series.

RESULTS

The collecting yielded a total of 42 species from the two investigated areas as listed below. The purpose of this contribution is not predominantly in the field of taxonomy, thus I relegate systematic and faunistic notes regarding the taxa concerned to an appendix to this paper.

"*Palpares*" *angustus* MCLACHLAN, 1898
"*Palpares*" *germaini* NAVÁS, 1921
Fadrina sp.
Centroclisis punctulata NAVÁS, 1912
Centroclisis cervina (GERSTAECKER, 1863)
Phanoclisis longicollis (RAMBUR, 1842)
Myrmecaelurus cf. *lachlani* NAVÁS, 1912
Myrmecaelurus medius NAVÁS, 1913
Nohoveus lepidus (KLUG, 1834)
Nohoveus palpalis (KLAPÁLEK, 1914)
Nophis teillardi NAVÁS, 1912
Lopezus arabicus HÖLZEL, 1972
Maracanda lineata NAVÁS, 1913
Gepus invisus NAVÁS, 1912
Gepus tersus NAVÁS, 1919
Solter liber NAVÁS, 1912
Cueta lineosa (RAMBUR, 1842)
Cueta pallens (KLUG, 1834)
Cueta sp. 3
Myrmeleon hyalinus OLIVIER, 1811

Myrmeleon fasciatus (NAVÁS, 1912)
Myrmeleon pseudofasciatus HÖLZEL, 1981
Macronemurus elegantulus MCLACHLAN, 1898
Mesonemurus harterti NAVÁS, 1920
Geyria lepidula (NAVÁS, 1912)
Geyria saharica ESBEN-PETERSEN, 1920
Neuroleon tenellus (KLUG, 1834)
Neuroleon leptaleus (NAVÁS, 1912)
Neuroleon dumontinus (NAVÁS, 1930)
Neuroleon sp. 3
Neuroleon numidus NAVÁS, 1928
Quinemurus cf. *cinereus* KIMMINS, 1943
Distoleon sp. 1
Distoleon cf. *annulatus* (KLUG, 1834)
Delfimeus scriptus NAVÁS, 1912
Creoleon cf. *arenosus* NAVÁS, 1934
Creoleon alternus NAVÁS, 1933
Creoleon sp. 3
Creoleon sp. 4
Creoleon sp. 5
Pseudoformicaleo gracilis (KLUG, 1834)
Ganguilus pallescens NAVÁS, 1912

At Bou Hedma, 26 of these species were collected represented by 222 specimens. Of these, 57 are from May/June, 154 from August/September and 11 from October. The numbers for Jbil were 505 specimens of 21 species. However, two of these, *Maracanda lineata* (in May/June) and *Geyria lepidula* (in August/September) were so abundant that not all specimens attracted to the light source were taken. *G. lepidula* was in fact the most numerous insect in one of the collecting nights (26.08.98) with up to about 250 present at the light trap. The estimated total for Jbil, considering specimens actually attracted, was thus about 450 Myrmeleontidae for May/June and over 700 for August/September; 23 each were collected in April and October.

Markedly different species arrays could be demonstrated at the two arid sites. Only 5 species were found at both (marked with X in Fig. 6), 3 of which were common to abundant at Jbil while represented by single or very few specimens in the Bou Hedma material. *Neuroleon dumontinus* (1 specimen at Bou Hedma) may have to be added to this group as it is possibly identical to *Neuroleon* sp. 3 from Jbil (see appendix). *Gepus invisus* was encountered more commonly at Bou Hedma than at Jbil, while *Distoleon* cf. *annulatus* is the only species almost equally represented at both localities. It is, however, seasonally peculiar, as it was virtually restricted to the October material. This very small but remarkably distinctive sample added 1 species to the Bou Hedma and 3 to the Jbil list, these latter representing over half of the individuals caught in October. The single but numerous species flying at Jbil in April, *Lopezus arabicus*, is also restricted to that time of the year.

A conspicuous segregation is also obvious between the two main collecting seasons, noticeable at both localities (Fig. 6). Only 6 species at Bou Hedma, and 3 at Jbil, were found both in late spring and late summer, most of which showed a clear preference for one of those periods.

The lower number of species and higher number of individuals at Jbil, mainly attributable to the above-mentioned very high numbers of two of the species, also account for a marked difference in dominance patterns between the two locations,

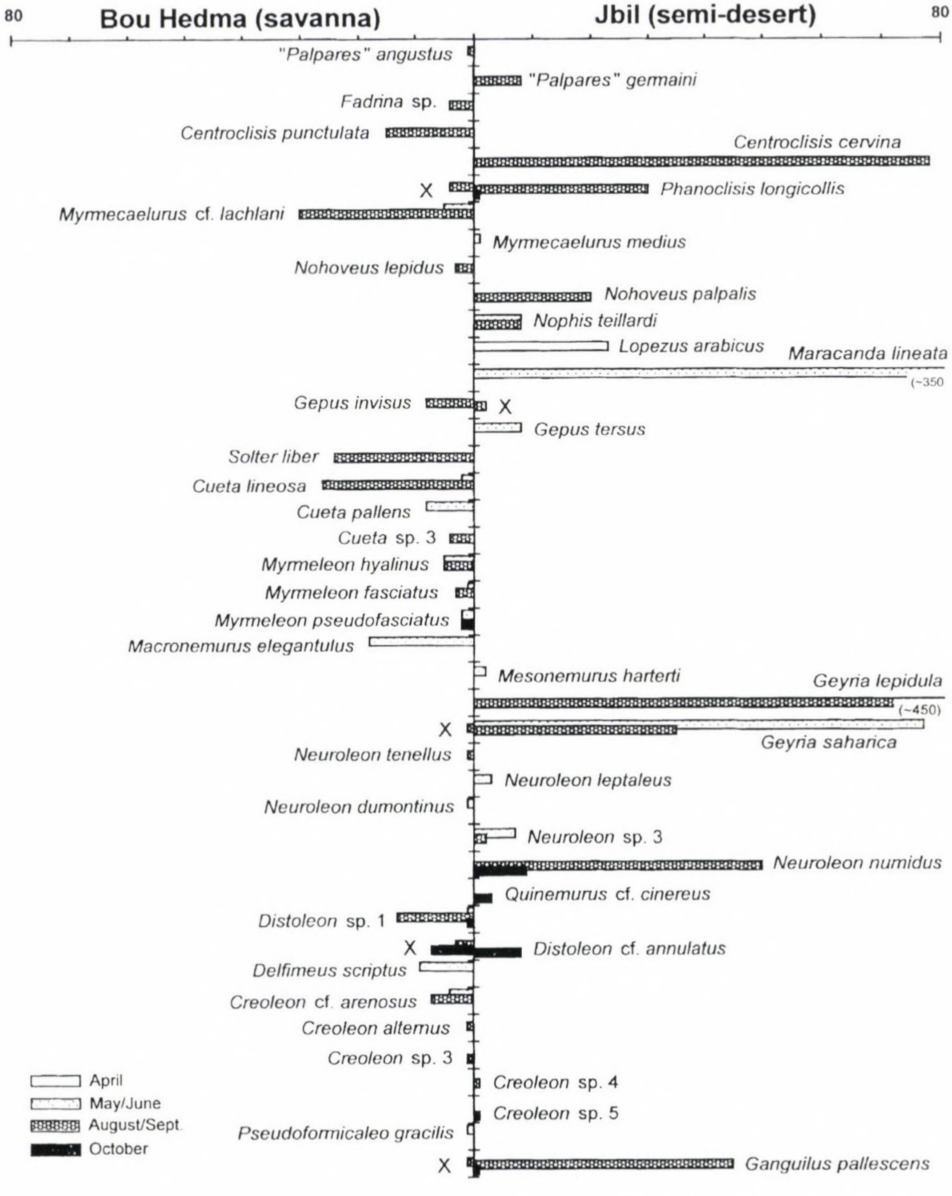


Fig. 6. Species and numbers of individuals of Myrmeleontidae caught at Bou Hedma and Jbil in 1998, 1999 and 2001, subdivided by season. X: species recorded at both sites

the acacia savanna showing a higher diversity. In May/June, *Maracanda lineata* accounted for over 3/4 of the catch at the semi-desert, and *Geyria lepidula* for over 60% in August/September. Just 2 species in late spring (5 in late summer) contributed well over 90% of specimens. In contrast, the single most numerous species at Bou Hedma were represented with only 1/3 and 1/5 of individuals in May/June and August/September, respectively. The three most common species contributed only just over 60% in the earlier and 50% in the later period, in which these 3 were caught in almost equal numbers.

The higher diversity of antlions at Bou Hedma in comparison to the semi-desert/erg ecotone at Jbil is certainly in part a reflection of the ecological circumstances. However, it needs to be noted that the effect is enhanced by the chosen black-lighting locations at Bou Hedma representing two distinct kinds of habitat. This can be demonstrated by comparing results from the 2 acacia savanna loca-

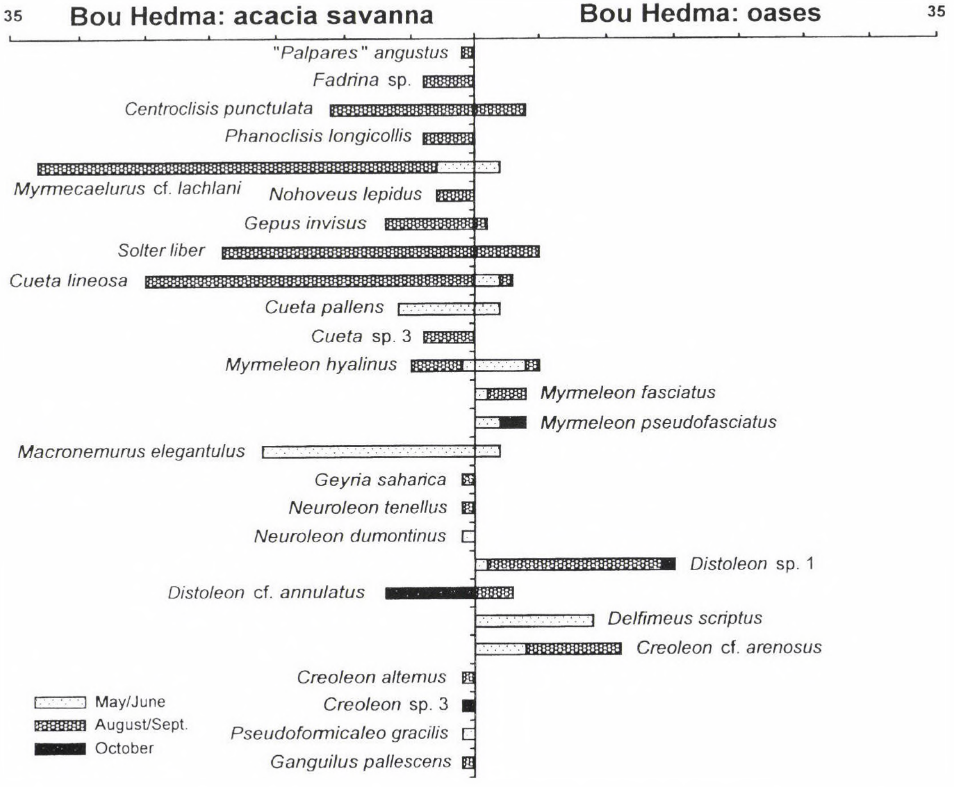


Fig. 7. Species and numbers of individuals of Myrmeleontidae caught at acacia savanna and oases light-trapping stations at Bou Hedma, subdivided by season

tions with those from the 2 locations at the mountain-base oases (Fig. 7). While those species represented by at least 5 specimens at the acacia savanna also occurred at the oasis sites, 5 species were found only at the latter, 3 of which constituted the most numerous ones there.

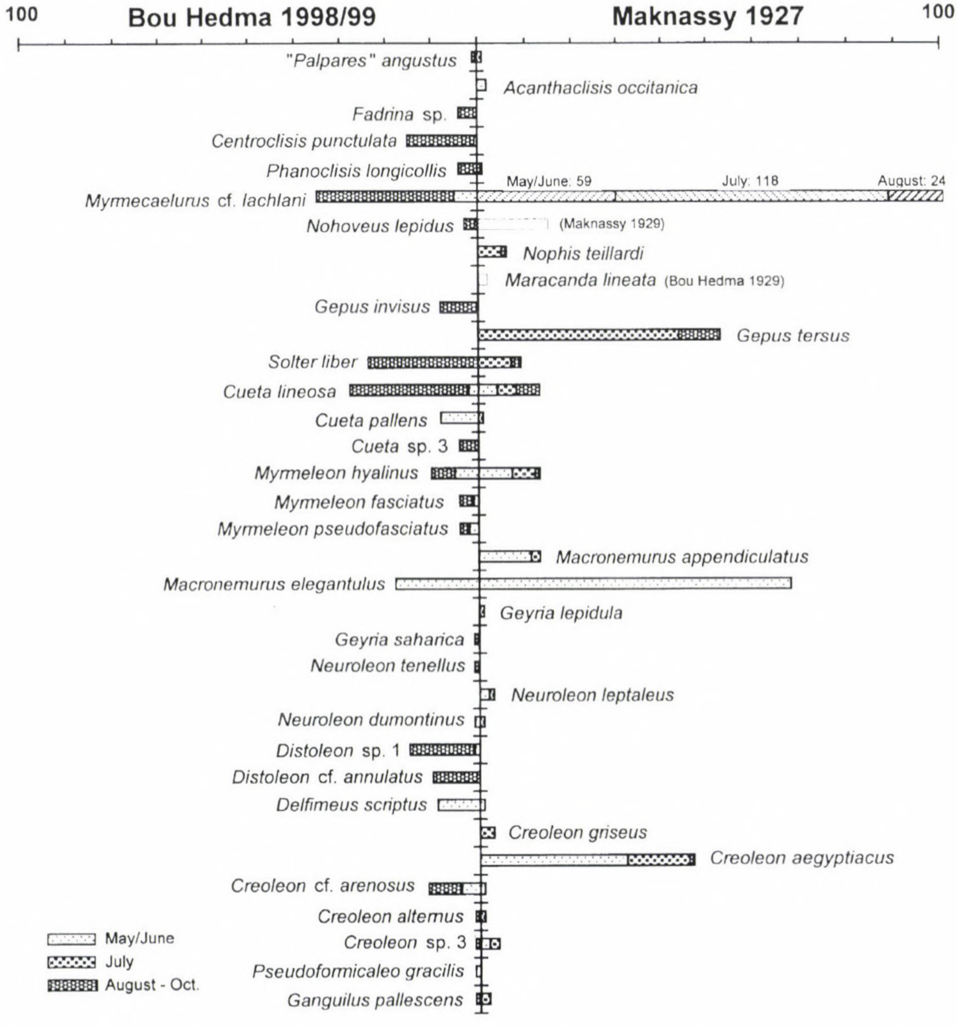


Fig. 8. Species and numbers of individuals of Myrmeleontidae caught at Bou Hedma (present study) and at Maknassy (C. DUMONT leg. 1927), subdivided by season. *Nohoveus lepidus* and *Maracanda lineata* added from other samples by DUMONT. Column size for *Myrmecaelurus* cf. *lachlani* on right hand side reduced by one half

Predictably, C. DUMONT's large sample of antlions from the year 1927 from Maknassy shows many similarities in species composition and abundance to the present collections from nearby Bou Hedma (Fig. 8). The *Myrmecaelurus* species is the most numerous in both, though a lot more dominant in the older material (nearly 50% compared to 16% over all seasons). This is partly because DUMONT collected 60% of the individuals of this species in July, obviously its main period of occurrence, during which I have not collected at Bou Hedma. In that month, the species accounted for more than 70% of specimens. *Macronemurus elegantulus* dominates in May/June, holding about 30% in both samples. Several moderately numerous species are about equally represented, showing the same seasonal preferences. The absence or near-absence of a few species in DUMONT's material is noteworthy. They are, on one hand, those which occur at Bou Hedma mainly or exclusively at the oases trapping locations (e.g. *Distoleon* sp. 1, *Myrmeleon fasciatus*, *M. pseudofasciatus*), on the other hand the two acanthaclisine species *Centroclisis punctulata* and *Fadrina* sp. Those species which are present only in the Maknassy sample also represent different groups. There are some further species which are shown here to be typical for the dwarf shrub semi-desert in addition to those also found sparsely in recent Bou Hedma material (e.g. *Nophis teillardi*, *Geyria lepidula*, with *Maracanda lineata* being added from DUMONT's small Bou Hedma sample). Again, these are represented by very few specimens, with the exception of *Gepus tersus*. More intriguing are *Acanthaclisis occitanica* (VILLERS, 1789), *Macronemurus appendiculatus* (LATREILLE, 1807) and *Creoleon aegyptiacus* (RAMBUR, 1842), the latter being the fourth-most numerous species in the Maknassy sample. These species are to be considered associated to Mediterranean-type habitats and are, in Tunisia, otherwise restricted to the northern third of the country. A further species restricted to DUMONT's collection is *Creoleon griseus* (KLUG, 1834).

DISCUSSION

The total of 42 antlion species found in the two areas explored, is remarkable in comparison to only 37 species recorded by ASPÖCK *et al.* (2001) for the whole of Tunisia, about 6 of which are to be regarded as Mediterranean faunal elements ordinarily not expected in the savanna and desert zone in question (but see below). However, the species number reported reflects to a large part the very limited collecting activities in Tunisia up to now, and also the country's small size compared to its neighbours. In fact, the Myrmeleontidae recorded from Algeria, Tunisia and Libya combined amount to 93 species (ASPÖCK *et al.* 2001). This includes numer-

ous names published by NAVÁS many of which will prove to be synonyms as far as they still can be elucidated, certainly more than offsetting the number of species still to be discovered. Thus, I reckon that there occur about 80 species of Myrmeleontidae in the mentioned 3 countries. Up to 70 of these may pertain to the eremial realm, so more than half of this prospected number occur at Bou Hedma and Jbil combined. The Maghrebinian fauna is obviously less rich than that of the sub-Saharan savanna belt where nearly 80 species were discovered in a restricted area of southern Mali alone (MICHEL 1999) – admittedly more humid than the region treated here. To cite another comparison, there are 113 species known from the Arabian Peninsula (HÖLZEL 1998), but no figures have been published for single localities there.

Habitat association

Few previous studies of myrmeleontid faunas in parts of the Palaearctic eremial assessed ecological requirements of species. Here, very distinct species compositions were discovered at two sites representing almost maximally different biotopes within the North African arid zone. The semi-desert/erg ecotone sampled constitutes one of the climatically and ecologically most extreme habitats where myrmeleontids can be expected (although it has not been examined which species, if any, might still be found in vegetationless sandy or stony desert). In contrast, acacia savanna, in a less arid variant in pristine condition, may have constituted a transition to arboreal biotopes. The savannas and steppes found today in the Maghreb south of the Atlas mountains exhibit various, usually severe degrees of degradation and desertification. Compared to unspoiled habitats, an impoverished fauna might be expected with an introgression of species typical for less vegetated areas. The presence of a few individuals of several species in the Bou Hedma and Maknassy samples, which are common in the dwarf shrub semi-desert (see Figs 6, 8), may be interpreted in that light. A comparative sampling of degraded steppe habitats would be of considerable interest.

Obviously it would be an over-simplification to regard the two locations visited as representing extremes in a linear array of habitat types to be found in the Maghrebinian savanna and steppe belt. Many older samples from that region appear to include representatives from both the Bou Hedma and the Jbil species assemblage, though small sample sizes and uncertainties of the reported identifications make interpretation difficult. Biotopes with a mixture of ecological properties may well have been involved. On the other hand, different, and in some cases rather distant, habitats sampled could have been reported under the same locality, as collection data used to be recorded with little precision. Old collection data will

thus be hard to evaluate in terms of ecological preferences of species. Many of the species recorded here at the erg/semi-desert ecotone have been cited rarely, or never before, for the Maghreb. Apparently, few previous excursions have touched this kind of habitat.

The comparison of results from the different light-trap locations at Bou Hedma reveal that some species detected are probably not associated with acacia savanna, occuring only at the oasis stations. *Myrmeleon fasciatus* can be connected with the presence of many cavelets along ravines at the foot of the mountain range where its larvae were found dwelling in considerable numbers. This may be true also for *Myrmeleon pseudofasciatus* even though the early stages of this species are not known. One of 11 specimens of *Creoleon* cf. *arenosus* was collected by day from grasses on the lower slopes of the mountains, possibly associating the species with that kind of habitat. The mountain grassland, typified by dense stands of halfa (*Stipa tenacissima* L.) differs considerably from the savanna plains where another esparto (*Lygeum spartum* LOEFL. ex L.) and sagebrush (*Artemisia herba-alba* ASSO) are more characteristic. The species *Delfimeus scriptus* and *Distoleon* sp. 1 may well be genuinely associated with oasis vegetation. There are a few records of the former from the Maghreb, all from the southern slope of the Saharian Atlas, which appears to be consistent with that presumption.

The most striking deviation of C. DUMONT's Maknassy sample from the present Bou Hedma material is the presence of some myrmeleontids which are to be regarded as Mediterranean rather than eremial faunal elements (see Fig. 8). Given the geographic location, this initially seems intriguing. The southern limit of distribution for Mediterranean fauna would ordinarily be expected in the south-eastern chain of the Atlas, the foothills of which are situated about 100 km to the northwest of Maknassy. Other data available from North Africa corroborate this. However, in the higher reaches of the Bou Hedma range, interspersed with halfa grasslands, one encounters tracts of very open juniper brush (Fig. 3), with some other shrubby vegetation of Mediterranean origin (e.g. *Pistacia* sp.) at the most sheltered spots. Surprisingly, two Mediterranean ascalaphids, *Libelloides ictericus* (DE CHARPENTIER, 1825) and *Deleproctophylla* sp. were observed flying here in early June. I suggest that DUMONT must have collected Mediterranean Myrmeleontidae on trips southward from Maknassy into the Bou Hedma chain. The collection data along with the high number of specimens indicate that DUMONT has been resident at Maknassy during the summer of 1927, making such excursions likely. For logistical reasons, I was unable to carry out black-lighting in the Bou Hedma mountains, which would be of special interest. The discovery of further Mediterranean faunal elements, which must be restricted to very isolated locations

that far south, would still add to the already impressive diversity of Neuroptera at this protected area.

Obviously the significance of Bou Hedma National Park is greatest for the preservation of species directly dependent on acacia trees. Both *Centroclisis punctulata* and *Fadrina* sp. are lacking in DUMONT's material and are, respectively, rare and absent in all other collections from North Africa, whereas at least the former species is common at Bou Hedma (they are not in DUMONT's Bou Hedma sample, because he collected there to early in the year – May and June). These two species may hence be the most partial to true acacia savanna and some ecological dependence on the tree itself may be suspected. *C. punctulata* also occurs rather commonly in the sub-Saharan savanna zone where, according to the collection data in PROST (1998), it prefers the most arid part, also with *Acacia raddiana*. The few localities in Israel and the Sinai and Arabian Peninsulas recorded for *Fadrina formosa* (HÖLZEL, 1981), which may be identical to the Tunisian *Fadrina* sp. (see appendix), are generally well-watered areas, some protected, favouring both growth of trees including acacias and their preservation.

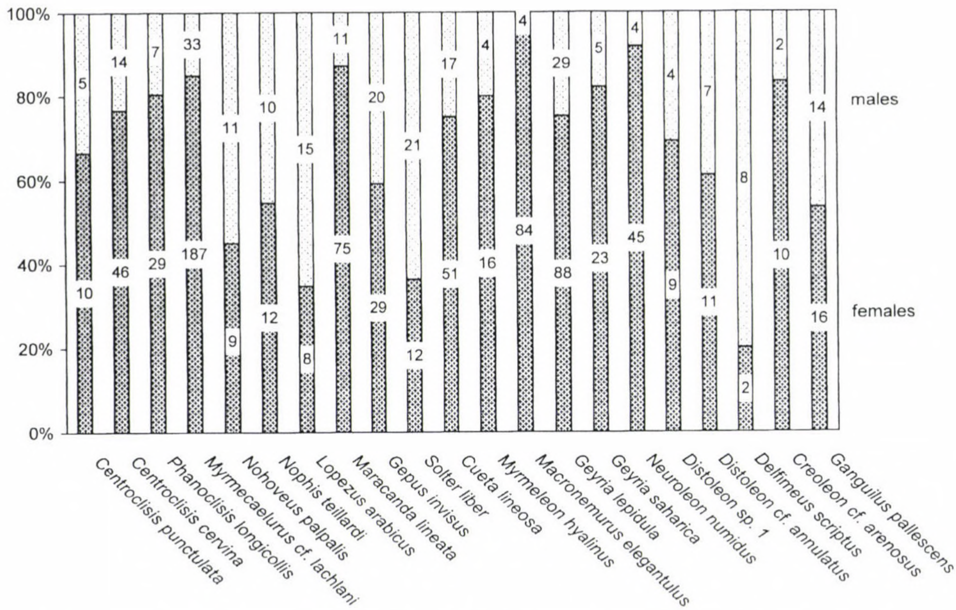


Fig. 9. Sex ratios encountered for antlion species at light traps in Tunisia. Species represented by less than 10 specimens in recent sampling omitted, DUMONT's material included for the presented species

Seasonality

A summary of the seasonal appearance of Palaearctic antlions by KRIVOKHATSKY (1998) shows adults of a majority of species to be encountered in August. While numbers of both species and individuals in the present study were clearly higher in August/September than in May/June, the seasonal seggregation proved considerable. About half of the species occurring in the early season were restricted to it, including the most numerous ones. KRIVOKHATSKY (1998) does not consider months beyond August in his summary. In the more temperate, arboreal regions of the Palearctic, records of antlions later than this month are rather sparse and virtually confined to September. They are more numerous in the eremial and there are indications from the material investigated here that adults of some species may be specialized for flying in September and October, possibly later. This pertains to *Distoleon* cf. *annulatus* as well as two species at Jbil probably assignable to *Quinemurus* (see appendix). Previous records of this genus are in line with this presumption (see HÖLZEL 1983, KRIVOKHATSKY 1992). As regards the mentioned *Distoleon* sp., it is noteworthy that *D. annulatus* is the only European antlion recorded as late as October according to ASPÖCK *et al.* (1980). At the savanna site, *Nohoveus lepidus* may be a late species, being present in Maknassy material from 1929, but not 1927 (see Fig. 8). In the earlier year, DUMONT discontinued collecting probably rather early in August, as concluded from the comparatively small overall number of specimens from that month. At the beginning of the season in the semi-desert, *Lopezus arabicus* was present as the only species in early April, but no longer found in late May. Previous, relatively numerous records of the species (as *L. fedtschenkoi* (MCLACHLAN, 1875)) from the Algerian Sahara date from February to May, with a single May citing from Nefta, Tunisia (NAVÁS 1930). Another species with a remarkable phenology is the ubiquitous pit-builder *Myrmeleon hyalinus*. It is the only antlion species in a small March sample from Bou Hedma, and DUMONT encountered one in November. In Arabia and the sub-Saharan steppe belt, adults of this species occur year-round (HÖLZEL 1987).

Light-trap performance

It is the usual perception that nearly all Myrmeleontidae – excepting some diurnal Palparini (e.g. *Pamexis* spp., MANSELL 1992*a*) – are attracted to light. Nonetheless, as in all studies envolving black-lighting or, in fact, other trapping methods, the trap responses cannot be taken as fully reliable representations of actual abundance of the species concerned. Light-trap responses of different species of Myrmeleontidae may differ for a multitude of reasons, possibly widely, so that

even relative catch rates of species in a given locality have to be viewed with care. The clearest indication for this is the very different sex ratios recorded for antlion species at light-traps in the present (Fig. 9) as well as previous studies, although this finding has rarely been stressed. It is deemed highly unlikely that distinct female preponderance of up to 95% represents the true sex ratio present in the population. While there is almost no information on life histories for most species, mating systems as described by YASSERI (1994) and YASSERI and PARZEFALL (1996) for the European *Euroleon nostras* (GEOFFROY, 1785) would predict sex ratios close to 1:1. However, trap responses are deemed associated with flight activity, as individuals are probably not attracted to light while inactive. Highly female-skewed sex ratios at light traps may thus be associated with stationary males attracting females as is the case in *Euroleon nostras*. Flight activity can also be linked to feeding or oviposition, the latter also promoting higher trap yields for females. Whatever the reason, there is strong indication that trap responses of the sexes differ distinctly in some species – so, therefore, may trap responses of different species, which is only harder to demonstrate. As there exists presently no alternative trapping method for myrmeleontids which would yield a sufficient catch to allow a meaningful comparison with black-lighting, this issue will be difficult to elucidate. There is circumstantial evidence that some species may – at least during certain periods – not have been attracted to the light source employed here. A single male of *Pseudoformicaleo gracilis* was caught out of a number of antlions hovering around the canopy of an acacia, possibly in mating activities. It appeared that they were all this species. Clearly they were not attracted to the light-trap in operation about 30 m distant. The single male of *Neuroleon dumontinus* was netted hovering around low bushes close to the light source, without showing orientation towards it.

Another issue touching the representation of population densities in the catch is the interpretation of the very high number of individuals encountered at the trap at Jbil, particularly of the dominant species *Maracanda lineata* early in the season and *Geyria lepidula* later. This may be caused either by a much greater radius of influence for the trap compared to the situation at Bou Hedma, by exceptionally high trap response of the species concerned under the given circumstances, or by genuinely high population densities. While the open landscape of the semi-desert in fact allowed the fluorescent lamps at Jbil to be seen from over 10 km distance by the human eye, it appears unlikely that the radius of influence was nearly that large, nor a lot larger than in the acacia savanna. For example, a 125 W mercury vapour bulb was calculated to show an effective radius – defined as the area in which the light-trap surpassed background light intensity – of just over 500 m maximally (*i.e.* under new moon conditions) in light-trapping campaigns in tropical Africa (BOWDEN

& MORRIS 1975). Hence, while the more structured vegetation at Bou Hedma may have accounted for a somewhat lower effective radius than at Jbil, all other factors deemed equal, it is unlikely that this has effected the trap performance severely. There is, further, no indication that the climatic and moon cycle conditions would have favored large turnouts particularly during the trapping days at Jbil. Successful trapping nights were characterized throughout by low winds and usually little moonlight. In fact, trapping at Jbil rather than at Bou Hedma was impared by an almost constant slight breeze. I can see no reason why *Maracanda lineata* and *Geyria lepidula* should show much higher trap responses than the other antlion species encountered. Both are very small species, so neither large areas of activity, nor above-average flight performance under somewhat unfavourable wind conditions would be expected (the latter may be true for the large *Centroclisis cervina*, also very numerous at Jbil). Possibly, species with more even sex ratios at light-traps – probably with mating systems not characterized by female attraction – may have higher trap responses overall if both sexes instead of only females show high flight activity. However, *Geyria lepidula* and *Maracanda lineata* showed strongly female-skewed sex ratios at the trap (see Fig. 9). It has thus to be concluded that the large numbers caught of these, and to a lesser extent some other species at Jbil, indeed represent, to a significant part at least, high population densities.

Larval niches

It is hard to reconcile the failure to discern larvae at the semi-desert/desert biotope with the postulated abundance of several species. The methods to detect non-pit-building antlion larvae employed at Jbil, all fruitless, were sieving sand from the bases of chamaephytes and grass tussocks as well as looking for tracks in the sand at night, and digging out clumps of vegetation during the day. It must be emphasized that the climate extremeties prevalent during the investigation period may have been particularly unfavorable for the detection of antlion larvae. Daily sand surface temperature approached 70°C both in early June and late August, so that arthropods needed to be hidden several decimeters deep. Even nocturnal activity periods may have been shortened and the possibility that some antlion larvae undergo a summer diapause under this climatic regime cannot be ruled out, even if such a case has yet to be demonstrated. Other workers at Jbil, though not specifically in search of antlions, have procured 3 larvae by digging out grass tussocks and a further one from its track at the sand surface in March and October. The difficulties of detecting non-pit-builders at Bou Hedma were less unexpected because of the hard soil surface of most tracts of open ground, even though it had been hoped that sifting litter under acacias would produce some results. Season may

again have been a factor. In a previous study of ground-dwelling arthropods at Bou Hedma, some myrmeleontid larvae were encountered in soil traps (MOLDRZYK pers. comm.).

It was quite obvious in the field that surface structure at Jbil does not support the construction of pitfall traps by antlions due to extremely fine-grained, movable dune sand. The sand-free tracts are characterized by an exceedingly solidified and stony surface. *Cueta lineosa* does occur in similar soil, e.g. around Cairo, but no pits were found at Jbil. The array of species collected at light seems to confirm the absence of pit-builders. Larvae of only two of the species have been described – *Phanoclisis longicollis* (STANGE & MILLER 1985) and *Nophis teillardi* (SIMON 1986) –, but the two genera of the region in which all species construct pits as far as known, *Myrmeleon* and *Cueta*, are conspicuously absent at Jbil. The tribe Myrmecaelurini, some species of which are known as facultative pit-builders, is represented by *Nophis teillardi*, which does not construct pits (SIMON 1986), by the virtually unknown *Myrmecaelurus medius* and by *Nohoveus palpalis*. Two larvae from Egypt from which *N. palpalis* could be reared were described by the collector as having been extracted from round shallow depressions reminiscent of, but not quite conforming to, typical antlion pits. The absence of pit-builders will probably be found a local phenomenon, not extending to every biotope influenced by dune sand. At the oasis of Douz, 50 km north of Jbil, adults of *Myrmecaelurus* cf. *lachlani* and *Myrmeleon hyalinus* were collected. In a semi-desert habitat nearby, similar to Jbil but deviating somewhat in surface structure and vegetation composition, pits of *Myrmecaelurus* sp. were detected in very sheltered spots under dense, low shrubs. At the acacia savanna at Bou Hedma, species of *Myrmeleon*, *Cueta* and *Myrmecaelurus* featured prominently in the adult trap yields (42% of specimens, see Fig. 6), and pits of all three genera were encountered.

Obviously, detecting larvae and describing feeding habits, connection to specific substrates and other ecological requirements will be paramount to understand the syntopic occurrence of so many species of Myrmeleontidae as demonstrated here as well as in other studies. While the adults of antlions may well show specific demands on the habitat (*e.g.* YASSERI 1994), the main differences between ecological niches will concern the life histories of larvae. MANSELL (1996) has reviewed the different habitats used by myrmeleontid larvae, but there is little information how non-pit-building psammophilous species, which is by far the largest group, differ in their specific niches. STEFFAN (1971) has demonstrated such differences for several species at the French Mediterranean coast. As regards the species treated here, there are a few laboratory observations on larvae of *Centroclisis punctulata* and *Phanoclisis longicollis* along with other Acanthaclisini by STANGE

and MILLER (1985) that revealed differences of feeding behaviour, though very few individuals were involved.

It will be a time-consuming task to describe niche seggregation of the numerous syntopic species through the habitat use of larvae, given the difficulties of studying them. Meanwhile, sampling of more localities for adults could shed some light on associations of species with certain ecological features of habitats and certain seasons. A revision of the North African Myrmeleontidae is desirable so as to be able to assign valid names to the investigated species.

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APPENDIX

In the following, some taxonomic notes are given regarding those species which have not yet been identified with certainty and thus were assigned provisional names in the present paper. Also, comments are added for some species of *Neuroleon* and *Creoleon* which could be identified to species described by NAVÁS (1928, 1930, 1933, 1934) from the vicinity, but for which probably older synonyms will surface upon revision. Generally, names could not be assigned to the majority of *Neuroleon*, *Distoleon* and *Creoleon* species due to the deficient state of knowledge of the systematics of these nemoleontine genera. I also mention new records for Tunisia. Note that some of the 42 species recorded here are not new for the country even though uncited by ASPÖCK *et al.* (2001); records have been detected and verified for these (*Phanoclisis longicollis*, *Nohoveus lepidus*, *Lopezus arabicus*, *Geyria lepidula*) in NAVÁS (1921*b*, 1930).

"*Palpares*" *germaini* NAVÁS, 1921 (Fig. 5) – The Palparini species found at the semi-desert locality could be securely identified as *Palpares germaini* NAVÁS, 1921, described from Béchar at the border of the Grand Erg Occidental in western Algeria. NAVÁS' description, for once extensive, matches to the detail, and M. W. MANSELL (Pretoria) kindly compared specimens from Tunisia with the holotype and previously single known specimen. Both this species and "*Palpares*" *angustus* are not longer regarded as belonging to *Palpares* RAMBUR, 1842 – their generic placement will be determined in the ongoing revision of the Palparini by M. W. MANSELL (see MANSELL 1992*b*).

Fadrina sp. – Antlions of this genus have not hitherto been reported from Northern Africa. The present specimens are not referable to *F. rufa* NAVÁS, 1912 which is rather common in the sub-Saharan savanna belt (PROST 1998), though apparently inhabiting rather southerly, more humid parts. However, it is very similar, possibly identical, to *Fadrina formosa* (HÖLZEL, 1981) from Israel, Sinai, the Arabian Peninsula and Sudan. The relation to *F. nigra* NAVÁS, 1912 from Yemen and East Africa also needs reinvestigation.

Centroclisis cervina (GERSTAECKER, 1863) – New for Tunisia.

Myrmecaelurus cf. *lachlani* NAVÁS, 1912 – All specimens of *Myrmecaelurus* s. str. are here subsumed under one species, in the absence of compelling evidence to the contrary. A few females from Bou Hedma appear distinctly aberrant, more material will have to be studied to determine if they may represent other species. The many specimens collected by DUMONT have been attributed to no less than 5 species by NAVÁS (1930): *M. lachlani* (predominantly), *M. trigrammus* PALLAS, 1771, *M. laetus* (KLUG, 1834), *M. tabarinus* NAVÁS, 1913 and *M. quedenfeldti* (KOLBE, 1884), the latter in fact belonging to *Macronemurus*. Viewing the material, there are no criteria discernible on which this distinction may have been based. Recently, a specimen of *Myrmecaelurus* s. str. from the Moroccan desert has been attributed to *M. lachlani* (MONSERRAT *et al.* 1990), though there seems to be doubt as the type was collected in the Moroccan Atlas mountains.

Myrmecaelurus medius NAVÁS, 1913 – The only specimen hitherto reported has been the female holotype from east of Ghardaia, Algeria, which is clearly conspecific with one male from Jbil. Male genitalic features place the species in the genus *Nohoveus* as presently conceived.

Nohoveus palpalis (KLAPÁLEK, 1914) – New for Tunisia.

Cueta sp. 3 – A few specimens from Bou Hedma differ clearly from the other two *Cueta* species recorded, showing the following combination of characters: wings narrow and unmarked as in *C. pallens* with pale unmarked venation, much smaller than that species (size as in small *C. lineosa*), male ectoprocts intermediate in length. It remains to be studied whether NAVÁS has hit this species among the wealth of new names he has supplied for North African *Cueta*. Most of these will probably prove to be synonyms of *C. lineosa* even though I suspect that the North African material assigned to the latter may contain a second, very similar species.

Myrmeleon pseudofasciatus HÖLZEL, 1981 – New for Tunisia and North Africa, hitherto known only from the Middle East.

Neuroleon dumontinus (NAVÁS, 1930) – One male from Bou Hedma can be unequivocally associated with a female in DUMONT's Maknassy material, the holotype of *Afroclimacius dumontinus* NAVÁS, 1930. The species recalls *Noaleon limbatellus* (NAVÁS, 1913) described from Algeria, especially as regards the very slender elongated legs, but wing structure and pattern differ.

Neuroleon sp. 3 – Differs from *N. dumontinus* very little, mainly in more heavily marked wings. The Bou Hedma and Jbil populations are being provisionally kept separate here.

Neuroleon numidus NAVÁS, 1928 – The species, common at Jbil, has been known before from the lone holotype from El Kantara in the Aurès range in eastern Algeria. That locality may be imprecisely reported: areas of sandy desert rather occur farther south near Biskra. The swelling of the male abdominal segments III and IV strongly suggests that the species be placed in the genus *Quinemurus* (compare figure in KRIVOKHATSKY 1992) though ectoproct and leg structure would appear not to be in accordance.

Quinemurus cf. *cinereus* KIMMINS, 1943 – Based on the structure of the cubital field in the hindwing this species seems also to belong to *Quinemurus*, and the similarity to *Q. cinereus* from Arabia is great. However, males have unfortunately not been found yet at Jbil.

Distoleon sp. 1 – It appears that this species is not identical with any described *Distoleon*. It is smaller than any other Palearctic species currently assigned to the genus with the exception of *D. gafsanus* (Navás, 1921). The latter originates from the Tunisia steppe zone and is apparently again smaller, but only parts of the body without wings remain of the type. A character which should make *D.* sp. 1 easily recognizable are numerous strongly elongated setae on the male hind tibiae (some more than half the length of the tibia itself).

Distoleon cf. annulatus (KLUG, 1834) – Both the Jbil and the Bou Hedma specimens are a lot paler and less extensively marked than any *D. annulatus* specimens I have seen, but there is no obvious structural difference.

Delfimeus scriptus NAVÁS, 1912 – New for Tunisia.

Creoleon cf. *arenosus* NAVÁS, 1934 – Being the only *Creoleon* represented here by more than one specimen, its similarity is greatest to *C. arenosus* described from Maknassy, but the identification is not certain as the latter is only known from a single discoulored type. In any case, it seems possible that a revision will turn up an older synonym.

Creoleon alternus NAVÁS, 1933 – There is one specimen each of *C. alternus* in DUMONT's material from Bou Hedma (type) and Maknassy , along with a further one in the recent sample. The species appears identical to one from the Middle East, Arabia and East Africa referred to as *C. irroratus* (KLUG, 1834) and *C. parallelus* (KLAPÁLEK, 1911) in recent publications (HÖLZEL 1972, 1983). These names are preoccupied and the valid name of this species will have to be determined. Numerous other described species are suspected to be the same.

Creoleon sp. 3 – A few specimens present among DUMONT's Myrmeleontidae and identical with one from Bou Hedma were determined by NAVÁS as *C. surcoufi* (NAVÁS, 1912) known from Algeria. I have not seen the type, but it is considered by HÖLZEL (1983) to be synonymous with *C. parallelus*. This suggests that it may be the same species as the previous one, and Arabian examples indeed show transitions. The obvious differential characters are size and falcation of wings which are of little taxonomic value. The fact that the (admittedly few) specimens from North Africa discretely form two groups suggests that they should be kept separate for the time being.

Creoleon sp. 4 – A single specimen from Jbil, August 1998, not assignable to species.

Creoleon sp. 5 – A single specimen from Jbil, October 1999, not assignable to species.

Ganguilus pallescens NAVÁS, 1912 – New for Tunisia.

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PATTERNS IN THE DISTRIBUTION OF AFROTROPICAL CHRYSOPIDAE

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Africa south of the Sahara has a comparatively rich fauna of Chrysopidae. Approximately 180 species in 26 genera have so far been recorded from the Afrotropical Region. The distribution of animals and plants on the continent is defined by the extensive area of lowland rainforest that covers West and Central Africa along the equator. This practically forms a barrier that divides the continent into two different savannah areas. Other important biomes are the isolated montane forests of East and Southeast Africa and three large arid areas: The Sudanese, the Somali and the Southwest arid zones include several important centres for insect distribution. About 100 species of the family occur in South and East Africa of which more than 40 have only been found in South Africa; 37 species and subspecies are probably endemic to the Madagascan subregion. The chrysopid fauna of the arid and semiarid parts of West Africa is rather poor, while the probably rich fauna of the West African rainforest and the West African savannahs is scarcely known.

Key words: Chrysopidae, Afrotropical Region, distribution, biogeography

INTRODUCTION

The Afrotropical region (sub-Saharan Africa, southwestern Arabia, Madagascar, Comoro, Mascarene Islands and Seychelles) has a comparatively rich fauna of Chrysopidae. Approximately 180 species in 26 genera have been recorded from the region. This number includes some synonyms but present research indicates that they will be offset by discovery of new species. The actual figure is probably about 250 species in 30 genera. This compares very well with the faunas of other regions, *e.g.* the Australian Region with 60 recorded species in 16 genera (NEW 1996), America North of Mexico with 80 species in 15 genera (PENNY *et al.* 1997) or the West Palaearctic fauna where recent research enumerated 140 species and subspecies in 16 genera (ASPÖCK *et al.* 2001).

The distribution of animals and plants on the African continent is influenced by the extensive area of lowland rainforest that covers West and Central Africa along the equator. This is essentially a barrier that divides the continent into two different savannah areas (ILLIES 1971). The only effective way for dispersal is through a small corridor in East Africa, between the large lakes and the high East African mountains and which eventually terminates in the Ethiopian highlands. It is therefore not surprising that the largest number of recorded Chrysopidae is in the

eastern half of the continent.The best investigated part of the continent is doubtless southern Africa in the region south of the Cunene and Zambezi rivers. In his revision of the Chrysopidae of this region BO TJEDER (1966) described and redescribed 77 species. This number has subsequently increased to about 90.

MATERIAL

The basic information for the compilation of species in Table 1 originates from the following papers: VAN DER WEELE (1909*a*, *b*), ESBEN-PETERSEN (1927), KIMMINS (1939, 1959), FRASER (1951, 1952, 1955, 1957), TJEDER (1966, 1976), BARNARD and BROOKS (1984), BROOKS (1984), SÉMÉRIA and QUILICI (1986), HÖLZEL (1987, 1989, 1990*a, b*, 1991, 1992, 1993, 1998), HÖLZEL and DUELLI 1990, 1994), HÖLZEL & OHM (1982, 1990, 1991*a*, 1991*b*, 1992, 1995), OHM and HÖLZEL (1982, 1992, 1995, 1997, 1998), HÖLZEL *et al.* (1991), HÖLZEL and MONSERRAT (1992), HÖLZEL *et al.* (1994, 1997), HÖLZEL *et al.* (1999), MANSELL (2000). Besides the published records, material collected by the authors in the last 15 years in Africa has been included in this study. Moreover most important data from the collection of African Chrysopidae in the National Collection of Insects, Pretoria, have been used. For these we wish to express our thanks to Dr. M. W. MANSELL, Pretoria.

CHRYSOPIDAE OF THE AFROTROPICAL REGION

Hundred eighty species and 6 subspecies are listed as occuring in the Afrotropical Region. They can be arranged into 10 groups on the basis of their current distribution in Africa. Owing to the scarcity of some species their assignment to one of the groups is presently tentative (Table 1).

West African lowland rainforest

The lowland rainforest has not been extensively explored. Up to now, 18 species have been recorded only from this region. A few have been collected once and never again in almost 100 years. On the other hand the rainforest has been colonised by several widespread species such as *Ceratochrysa antica, Chrysoperla congrua, Dichochrysa sjoestedti, Mallada desjardinsi.* The recorded distribution of *Glenochrysa conradina* is illustrated in Figure 1.

Table 1. Chrysopidae of the Afrotropical Region*

Fam. Chrysopidae	1	2	3	4	5	6	7	8	9	10
Subfam. Nothochrysinae										
Kimochrysa africana (KIMMINS, 1937)							o			
K. impar TJEDER, 1966							o			
K. raphidioides TJEDER, 1966							o			
Pamochrysa stellata TJEDER, 1966							o			
Subfam. Apochrysinae										
Apochrysa leptalea (RAMBUR, 1842)							o			
A. wagneri HÖLZEL, 1996		o								
Anapochrysa voeltzkowi (WEELE,1909)									o	
Subfam. Chrysopinae										
Tribe Ankylopterygini										
Ankylopteryx alluaudi NAVÁS, 1910								o		
A. buettikoferi VAN DER WEELE, 1905	o									
A. collarti NAVÁS, 1925	o									
A. fastuosa NAVÁS, 1929	o									
A. modesta HÖLZEL et OHM, 1991				o						
A. nepheloptera NAVÁS, 1912	o									
A. overlaeti NAVÁS, 1936	o									
A. pallidula TJEDER, 1966							o			
A. pusilla TJEDER, 1966							o			
A. splendidissima GERSTÄCKER, 1884	o									
A. tanana FRASER, 1952								o		
A. venusta (HAGEN, 1853)							o			
Genus *Parankylopteryx* TJEDER, 1966										
P. maculata (KIMMINS, 1939)		o								
P. multipunctata (FRASER, 1951)								o		
P. polysticta (NAVÁS, 1910)							o			
P. speciosa (NAVÁS, 1924)		o								
P. tenuis HÖLZEL, STELZL et OHM, 1991	o									
P. waterloti (NAVÁS, 1911)	o									
Tribe Belonopterygini										
Genus *Chrysacanthia* LACROIX, 1923										
C. varicella (FRASER, 1951)								o		
Genus *Chrysaloysia* NAVÁS, 1927										
C. somalica NAVÁS, 1927				o						
Genus *Dysochrysa* TJEDER, 1966										
D. furcata TJEDER, 1966									o	
Genus *Italochrysa* PRINCIPI, 1946										
I. amplipennis TJEDER, 1966							o			
I. asirensis HÖLZEL, 1980				o						
I. bimaculata HÖLZEL, 1980					o					
I. boueti (NAVÁS, 1927)								o		
I. burgeoni (NAVÁS, 1924)										o
I. exilis TJEDER, 1966							o			
I. falcata TJEDER, 1966							o			

Table 1 (continued)

Fam. Chrysopidae	1	2	3	4	5	6	7	8	9	10
I. fulvicornis KIMMINS, 1955							o			
I. gigantea (MCLACHLAN, 1867)							o			
I. guerini (NAVÁS, 1911)										o
I. impar (NAVÁS, 1912)							o			
I. limbata (NAVÁS, 1924)								o		
I. lobini HÖLZEL et OHM, 1982					o					
I. lyrata TJEDER, 1966							o			
I. madagassa HÖLZEL et OHM, 1995								o		
I. mozambica (WALKER, 1860)							o			
I. neurodes (RAMBUR, 1842)						o				
I. nossibensis (NAVÁS, 1928)								o		
I. okavangoensis TJEDER, 1966						o				
I. peringueyi (ESBEN-PETERSEN, 1920)							o			
I. pittawayi HÖLZEL, 1988					o					
I. rufostigma (MCLACHLAN, 1867)							o			
I. sectoria (NAVÁS, 1925)	o									
I. serrata TJEDER, 1966						o				
I. similis TJEDER, 1966									o	
I, stigmalis (NAVÁS, 1928)										o
I. temerata (NAVÁS, 1914)	o									
I. turneri (KIMMINS, 1948)						o				
I. variegata (BURMEISTER, 1839)							o			
I. zulu TJEDER, 1966							o			
Genus *Nesochrysa* NAVÁS, 1910										
N. grandidieri NAVÁS, 1910								o		
N. illota (TJEDER, 1966)							o			
N. macrostigma (GERSTÄCKER, 1894)	o									
N. marginata (NAVÁS, 1912)								o		
N. marginicollis (KIMMINS, 1957)							o			
N. rubeola (TJEDER, 1966)							o			
N. ruficeps (TJEDER, 1966)							o			
N. virgata (TJEDER, 1966)							o			
Genus *Oyochrysa* BROOKS, 1985										
O. ancora BROOKS, 1985			o							
O. sanguinea BROOKS, 1985			o							
O. spadix BROOKS, 1985			o							
Genus *Turnerochrysa* KIMMINS, 1935										
T. mirifica KIMMINS, 1935						o				
Tribe Chrysopini										
Genus *Apertochrysa* TJEDER, 1966										
A. eurydera (NAVÁS, 1910)									o	
A. umbrosa (NAVÁS, 1914)									o	
Genus *Borniochrysa* BROOKS et BARNARD, 1990										
B. squamosa (TJEDER, 1966)									o	

Table 1 (continued)

Fam. Chrysopidae	1	2	3	4	5	6	7	8	9	10
Genus *Brinckochrysa* TJEDER, 1966										
B. alfierii (NAVÁS, 1926)					o					
B. antennalis (NAVÁS, 1914)										o
B. beninensis HÖLZEL et DUELLI, 1994	o									
B. chlorosoma (NAVÁS, 1915)									o	
B. lauta (ESBEN-PETERSEN,1927)							o			
B. notabilis (HÖLZEL et OHM, 1991)				o						
B. plagata (NAVÁS, 1929)					o					
B. pulchella HÖLZEL, 1989							o			
B. stenoptera (NAVÁS, 1910)									o	
B. tjederi HÖLZEL, 1989							o			
B. turkanensis (NAVÁS, 1936)									o	
Genus *Ceratochrysa* TJEDER, 1966										
C. antica (WALKER, 1853)									o	
C. ceratina (NAVÁS, 1910)							o			
C. disparilis (NAVÁS, 1934)								o		
Genus *Chrysemosa* BROOKS et BARNARD, 1990										
C. commixta (TJEDER, 1966)							o			
C. jeanneli (NAVÁS, 1915)									o	
C. mosconica (NAVÁS, 1931)				o						
C. parva (TJEDER, 1966)						o				
C. piresi (HÖLZEL et OHM, 1982)					o					
C. senegalensis HÖLZEL, OHM et STELZL, 1994				o						
C. stigmata (NAVÁS, 1936)										o
C. umbralis (NAVÁS, 1933)								o		
Genus *Chrysocerca* VAN DER WEELE, 1909										
C. nigrivultuosa (KIMMINS, 1955)									o	
Genus *Chrysoperla* STEINMANN, 1964										
C. brevicollis (RAMBUR, 1842)								o		
C. carnea (STEPHENS, 1836) s. l.					o					
C. comans (TJEDER, 1966)							o			
C. congrua (WALKER, 1853)									o	
C, decaryana (NAVÁS, 1934)								o		
C. exul (MCLACHLAN, 1869)										o
C. insulata (FRASER, 1957)								o		
C. nyerina (NAVÁS, 1933)							o			
C. plicata (TJEDER, 1966)									o	
C. pudica (NAVÁS, 1913)									o	
C. volcanicola HÖLZEL, OHM et DUELLI, 1999							o			
C. zastrowi (ESBEN-PETERSEN, 1928)						o				
Genus *Crassochrysa* HÖLZEL, 1990										
C. aculeata (TJEDER, 1966)							o			
C. proxima HÖLZEL, 1990							o			
C. somalica HÖLZEL et OHM, 1991				o						

Table 1 (continued)

Fam. Chrysopidae	1	2	3	4	5	6	7	8	9	10
Genus *Cunctochrysa* HÖLZEL, 1970										
C. kannemeyeri (ESBEN-PETERSEN, 1920)							o			
Genus *Dichochrysa* YANG, 1991										
D. alliumolens HÖLZEL, OHM et STELZL, 1997						o				
D. amseli (HÖLZEL, 1980)					o					
D. arabica HÖLZEL, 1995					o					
D. atrosparsa (TJEDER, 1966)							o			
D. basuto (TJEDER, 1966)							o			
D. bibens HÖLZEL, OHM et STELZL, 1997						o				
D. birungana (NAVÁS, 1924)										o
D. caffer (TJEDER, 1966)							o			
D. chlorella (NAVÁS, 1915)										o
D. chloris (SCHNEIDER, 1851)							o			
D. collartina (NAVÁS, 1932)	o									
D. congolana (NAVÁS, 1911)	o									
D. decaryna (NAVÁS, 1924)								o		
D. decolor (NAVÁS, 1913)	o									
D. duplicata duplicata (NAVÁS, 1934)								o		
D. d. mascarenica HÖLZEL et OHM, 2000								o		
D. d. polyneura (NAVÁS, 1940)								o		
D. gunvorae (TJEDER, 1966)							o			
D. hamata (TJEDER, 1966)							o			
D. handschini (NAVÁS, 1929)							o			
D. incongrua (FRASER, 1951)								o		
D. incrassata (TJEDER, 1966)							o			
D. ingae (TJEDER, 1966)							o			
D. iniqua (NAVÁS, 1931)										o
D. inopinata HÖLZEL et OHM, 1995								o		
D. karooensis (HÖLZEL 1993)						o				
D. kibonotoensis (VAN DER WEELE,1910)							o			
D. luaboensis (TJEDER, 1966)									o	
D. marchionissa (NAVÁS, 1915)										o
D. mauriciana (HÖLZEL et OHM, 1991)								o		
D. militaris HÖLZEL et OHM, 2000								o		
D. namibensis (HÖLZEL, 1993)						o				
D. nicolaina (NAVÁS, 1929)									o	
D. nigra (MCLACHLAN, 1869)					o					
D. nyassalandica (NAVÁS, 1914)							o			
D. oralis (NAVÁS, 1914)										o
D. perpallida (TJEDER, 1966)							o			
D. pervenosa (TJEDER, 1966)							o			
D. pulchrina (TJEDER, 1966)							o			
D. raedarii HÖLZEL et OHM, 2000								o		
D. rothschildi (NAVÁS, 1915)										o
D. rubicunda (HÖLZEL, 1993)						o				

Table 1 (continued)

Fam. Chrysopidae	1	2	3	4	5	6	7	8	9	10
D. rubra (HÖLZEL, OHM et STELZL, 1994)	o									
D. sansibarica (KOLBE, 1897)							o			
D. setosa HÖLZEL et OHM, 1995								o		
D. sjoestedti (VAN DER WEELE, 1910)									o	
D. spadix (HÖLZEL, 1988)					o					
D. spissinervis (TJEDER, 1966)							o			
D. tacta (NAVÁS, 1921)						o				
D. teiresias (HÖLZEL & OHM, 1982)					o					
D. varians (KIMMINS, 1959)		o								
D. venosella (ESBEN-PETERSEN, 1920)							o			
D. zulu (TJEDER, 1966)							o			
Genus *Glenochrysa* ESBEN-PETERSEN 1920										
G. conradina (NAVÁS, 1910)	o									
G. insularis insularis HÖLZEL, 1991								o		
G. i. grancomorensis HÖLZEL et OHM, 2000								o		
G. i. mayottensis HÖLZEL et OHM, 2000								o		
G. principissa (NAVÁS, 1915)							o			
Genus *Mallada* NAVÁS, 1925										
M. desjardinsi (NAVÁS, 1911)									o	
M. meloui (NAVÁS, 1924)	o									
Genus *Plesiochrysa* ADAMS, 1982										
P. litorosa (NAVÁS, 1911)								o		
P. scotti (ESBEN-PETERSEN,1927)								o		

* 1 = West African rainforest; 2 = East African montane forests; 3 = West African savannah; 4 = Somali arid; 5 = Sudanese arid; 6 = Southwestern-arid; 7 = East and Southeast Africa; 8 = Madagascan subregion; 9 = Pan African species; 10 = distribution unknown.

East African montane forests

The insect fauna of the montane evergreen forests of East and Southeast Africa is poorly known. In addition to the four listed species of Chrysopidae, descriptions of three further species are in press.

West African savannah

The fauna of the West African savannah is virtually unknown. The four listed species have only been recorded once in Nigeria and in Senegal.

Somali arid zone

There is a poorly known arid-adapted fauna in the horn of Africa. So far, 18 species are known, six of which seem to be endemics; one of them, *Chrysaloysia somalica*, belongs to an endemic genus. The recorded distribution of *Chrysemosa mosconica* is shown in Fig. 2, as an example.

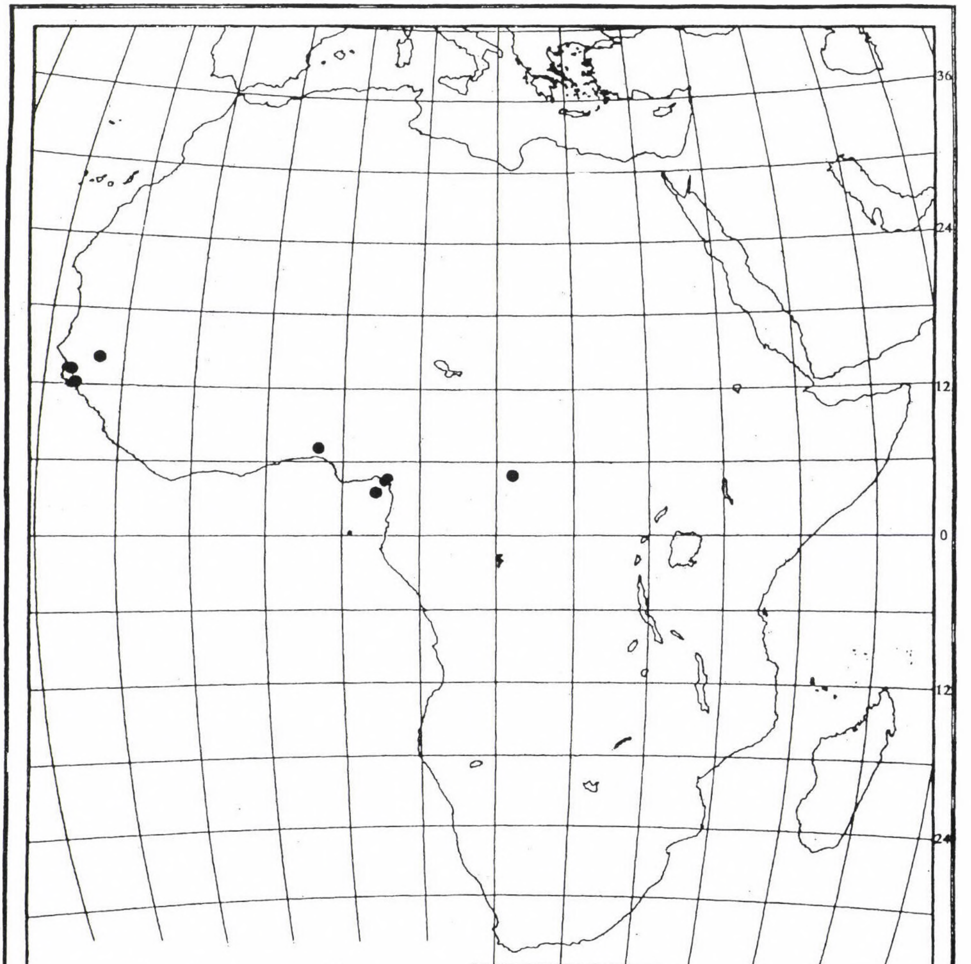


Fig. 1. Recorded distribution of *Glenochrysa conradina*

Sudanese arid zone

The 12 species known from this region manifest three distributional trends. A western faunal component with three species, *Dichochrysa nigra, D. teiresias,* endemic to the Cape Verde Islands and *Chrysemosa piresi* occuring on the Cape Verdes and in northwestern Senegal. An eastern faunal component with five spe-

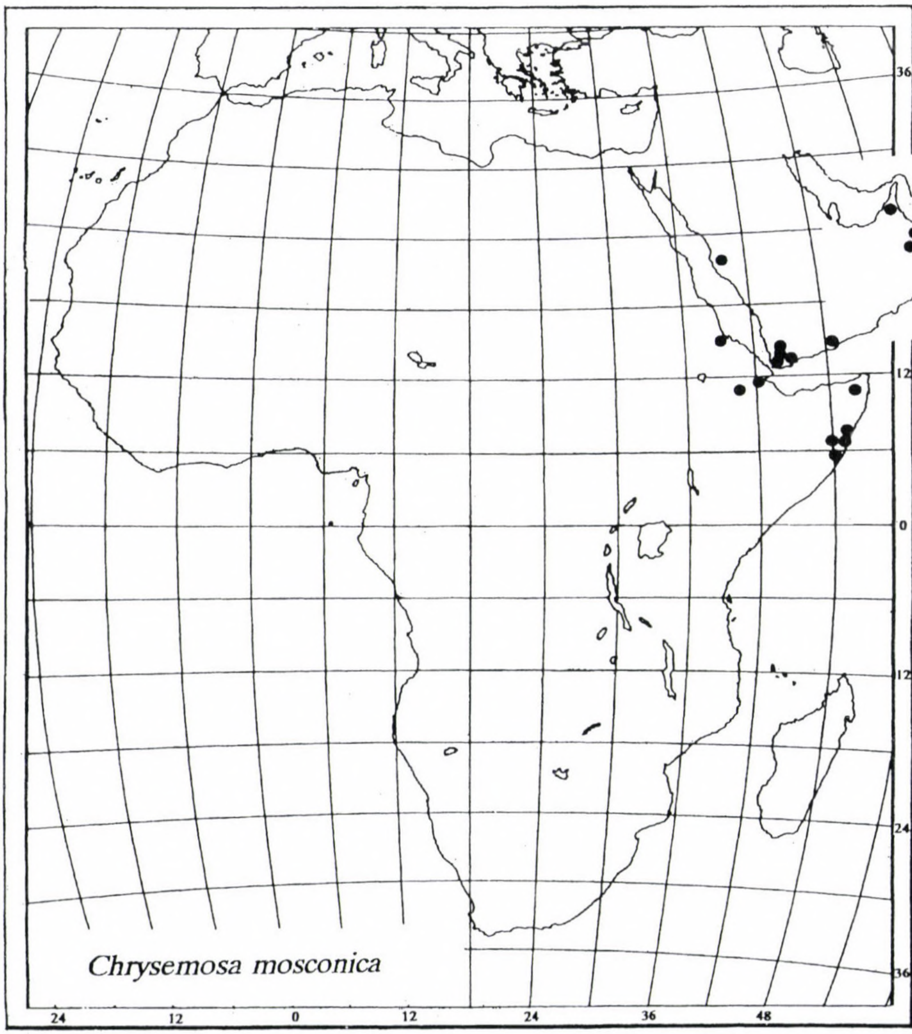


Fig. 2. Recorded distribution of *Chrysemosa mosconica*

cies: *Italochrysa pittawayi* and *Dichochrysa arabica* endemic to the SW Arabian peninsula, *D. amseli, D. spadix* and *Brinckochrysa alfierii* in SW Arabia and Sudan. More widespread faunal elements represent the other four species: *Italochrysa bimaculata* from NW Senegal, Tunisia and Yemen, *Brinckochrysa plagata* (Fig. 3) from the Cape Verde Islands, Sudan and the southern Arabian peninsula, *Italochrysa lobini* from the Cape Verde Islands, Nigeria and the Hoggar mountains in Algeria and *Chrysoperla carnea* s. l. (a taxon of this group, which can be well

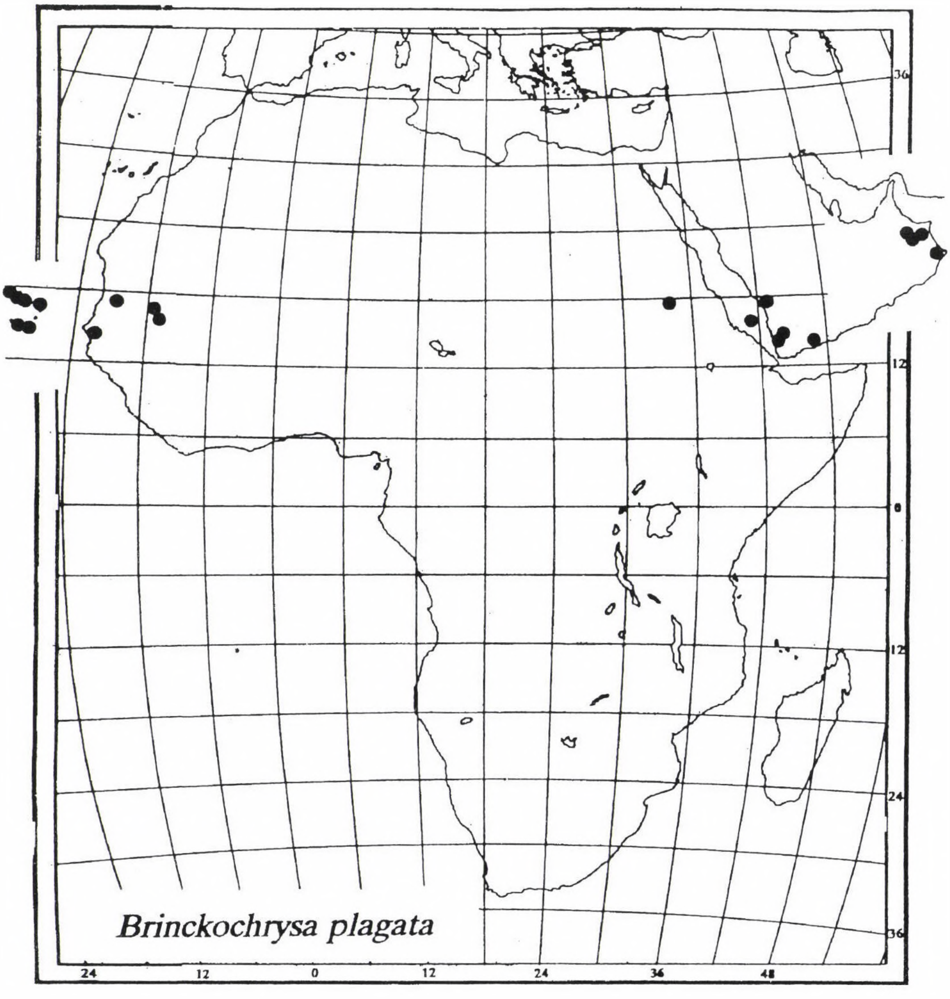


Fig. 3. Recorded distribution of *Brinckochrysa plagata*

differentiated morphologically) from the Cape Verde Islands, Senegal, Ethiopia, Sudan and the southern Arabian peninsula.

Southwestern African arid zone

This area includes the best investigated parts of the continent. Of 29 species found in this region no less than 16 are probably endemics. Five species occur also in southeast Africa and the other eight are wide spread over the continent.

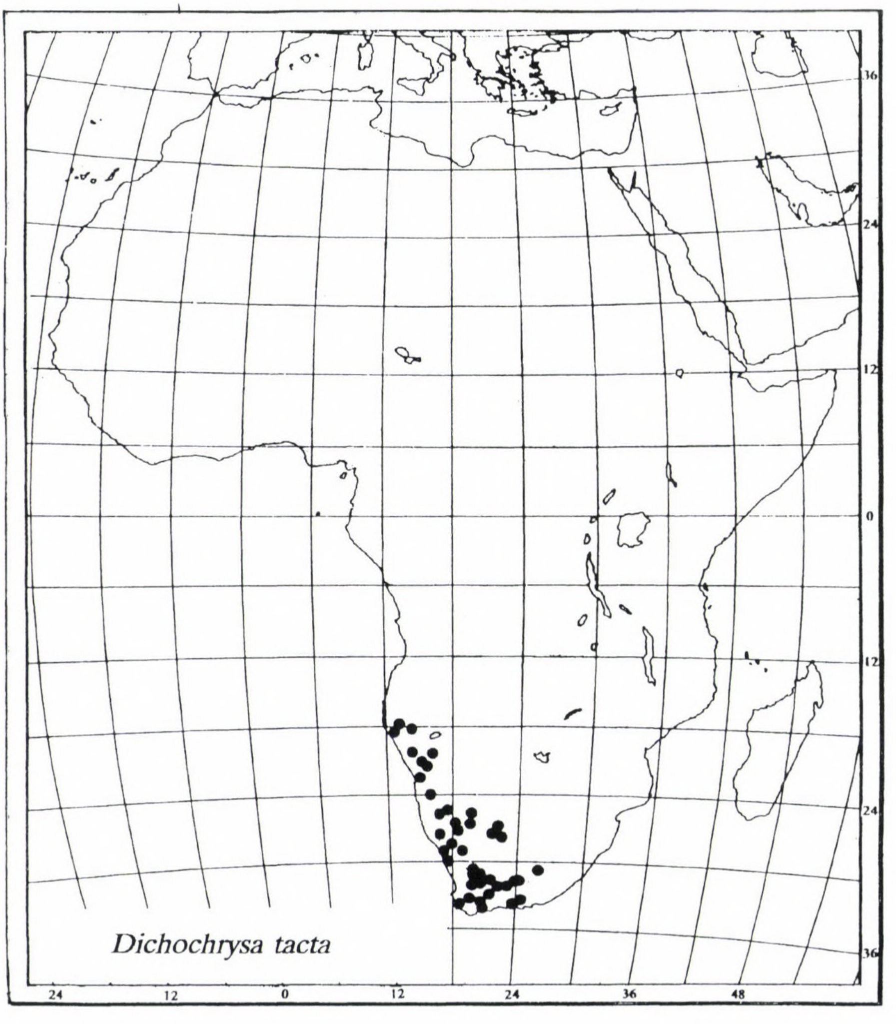


Fig. 4. Recorded distribution of *Dichochrysa tacta*

The 16 apparently endemic species manifest several distributional trends. The distribution of *Italochrysa neurodes, Dichochrysa karooensis, D. rubicunda* and two undescribed species is limited to the Karoo in the Cape Province. *Chrysemosa parva* has, so far, only been found in a small area in the Kalahari, *Dichochrysa namibensis* in the Namib desert at Gobabeb and *Dichochrysa* sp. on the Brandberg massif. *Dichochrysa alliumolens, D. bibens, Italochrysa serrata, I. okavangoensis* and *Turnerochrysa mirifica* are known from single records in Na-

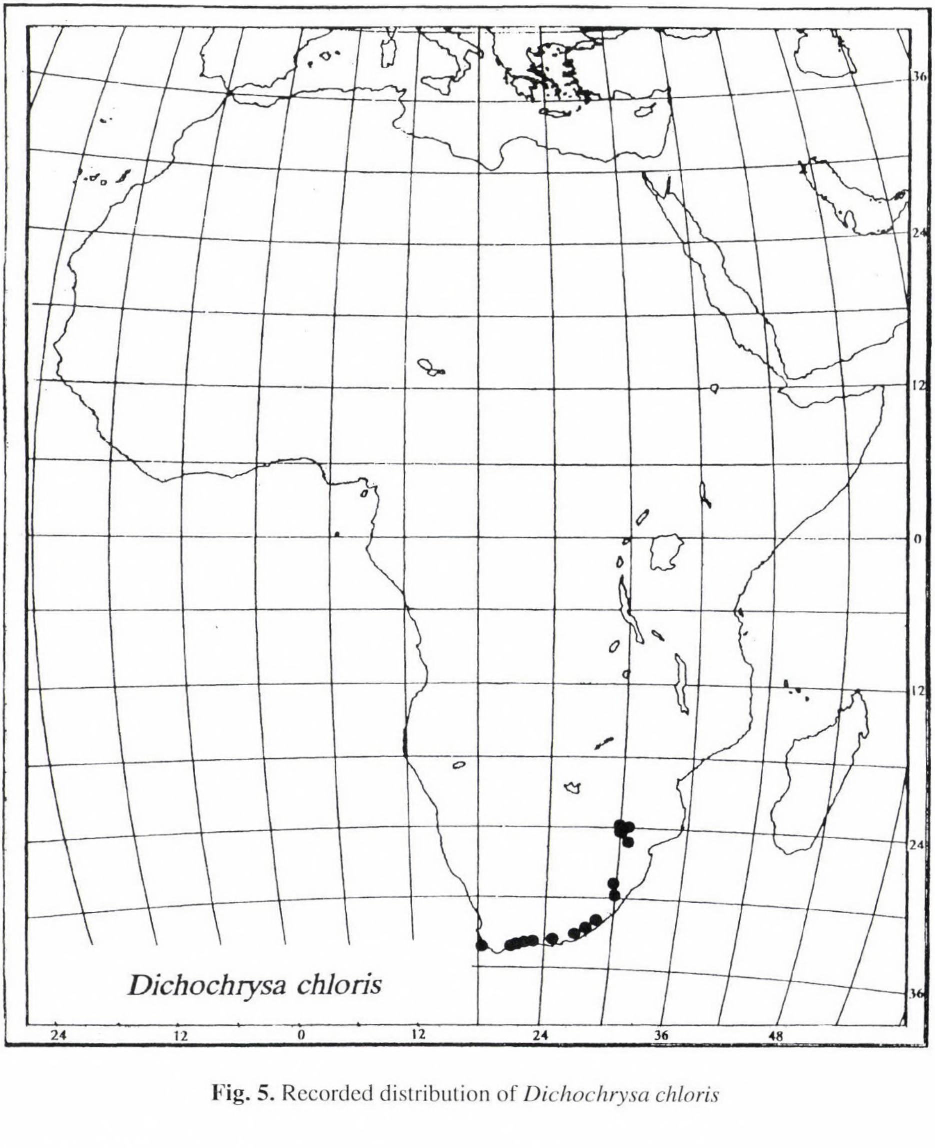


Fig. 5. Recorded distribution of *Dichochrysa chloris*

mibia, only *Dichochrysa tacta* (Fig. 4), *Chrysoperla zastrowi* and *Italochrysa turneri* represent more widespread faunal elements.

East and southeast Africa

The 56 species recorded from this region manifest at least three distributional patterns. Northern faunal component: a few East African species have not been

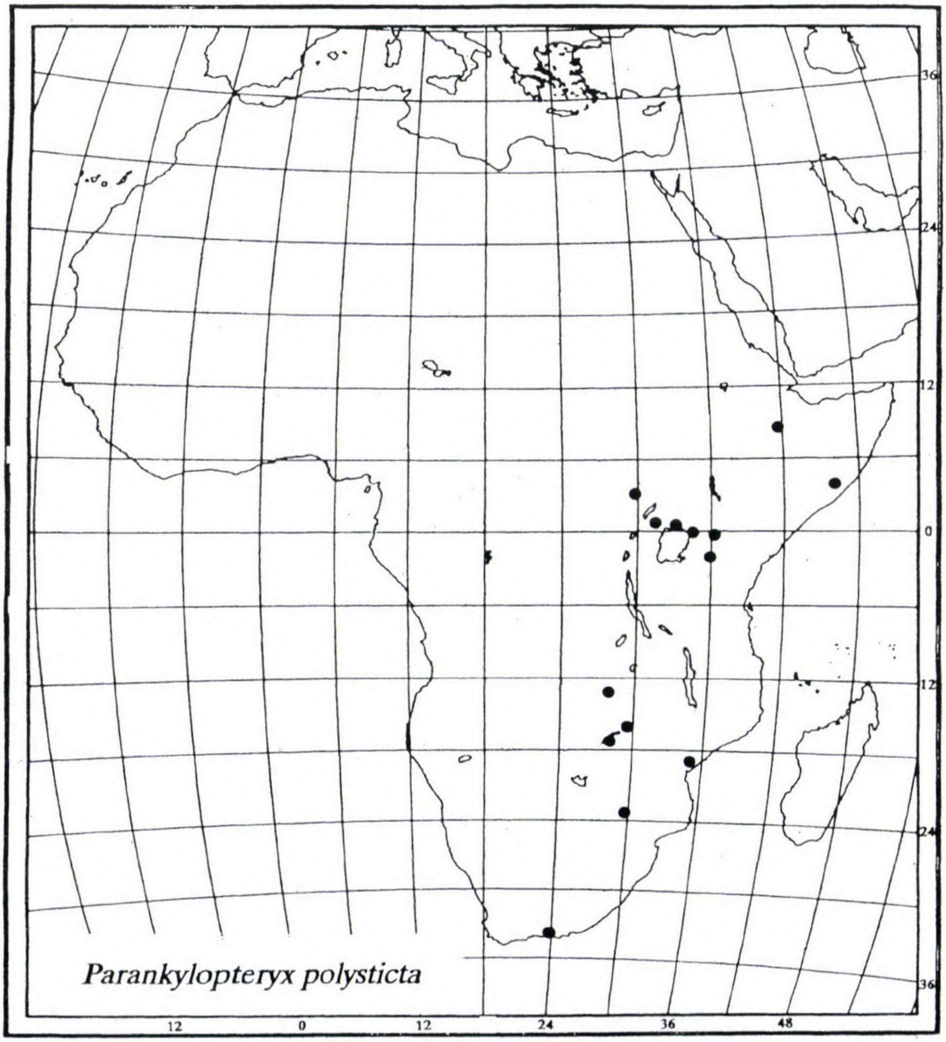


Fig. 6. Recorded distribution of *Parankylopteryx polysticta*

found south of the Zambezi river. *Nesochrysa marginicollis* occurs in Tanzania, while *Chrysoperla nyerina* occurs only in Kenya, *Dichochrysa sansibarica* is only known from the island of Zanzibar and *Chrysoperla volcanicola*, described from Ethiopia, extends to the Comoro islands (Grande Comoro).

Eastern faunal component: 47 species occur in the eastern parts of southern Africa and do not extend into the Southwestern African arid zone: *Kimochrysa*

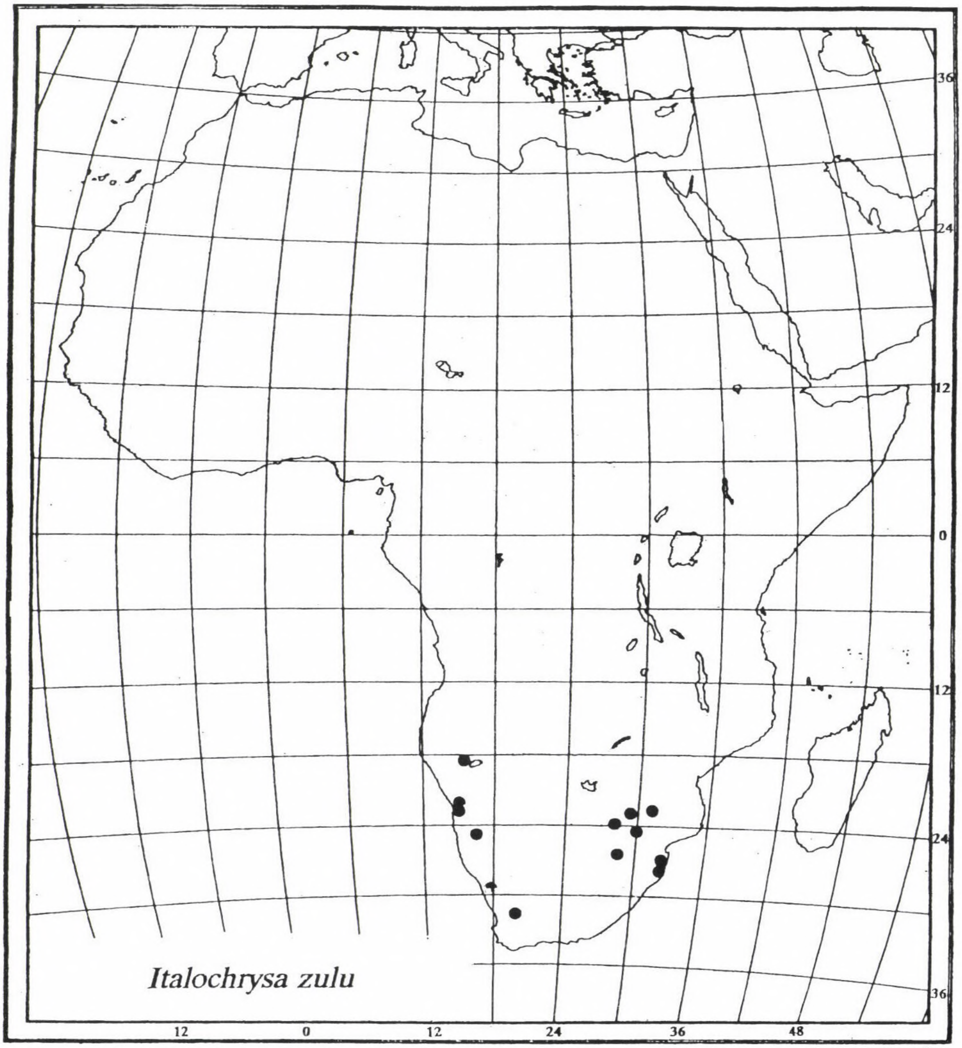


Fig. 7. Recorded distribution of *Italochrysa zulu*

africana, K. impar, K. raphidioides, Pamochrysa stellata, Apochrysa leptalea, Ankylopteryx pusilla, Italochrysa amplipennis, I. exilis, I. falcata, I. fulvicornis, I. gigantea, I. lyrata, I. mozambica, I. rufostigma, Nesochrysa illota, N. rubeola, N. ruficeps, N. virgata, Ceratochrysa ceratina, Crassochrysa aculeata, C. proxima, Cunctochrysa kannemeyeri, Dichochrysa atrosparsa, D. basuto, D. caffer, D. chloris (Fig. 5), *D. gunvorae, D. incrassata, D. ingae, D. perpallida, D. pervenosa,*

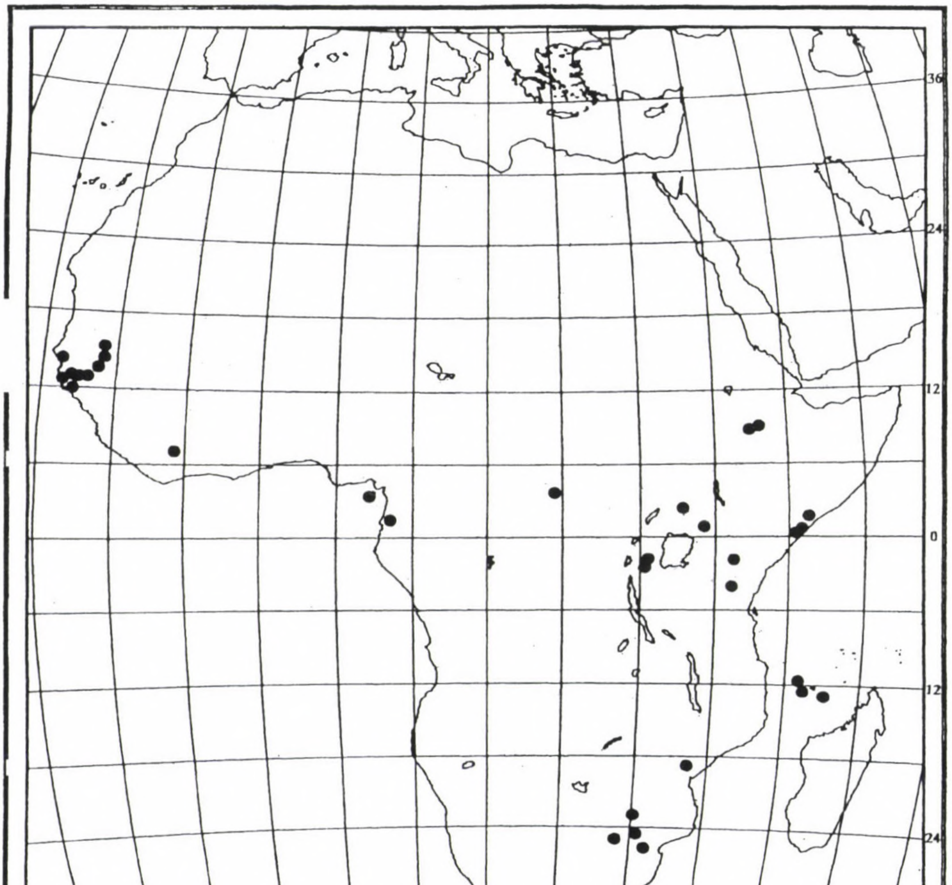


Fig. 8. Recorded distribution of *Dichochrysa sjoestedti*

D. pulchrina, D. spissinervis, D. venosella and *D. zulu.* Some extend to the islands of the Madagascan subregion or to the north, in some cases up to Ethiopia. These include *Ankylopteryx pallidula, A. venusta, Parankylopteryx polysticta* (Fig. 6), *Italochrysa peringueyi, I. variegata, Brinckochrysa lauta, Chrysoperla comans, D. kibonotoensis, D. hamata, D. handschini, D. nyassalandica* and *Glenochrysa principissa.*

General faunal component: only a few species are widespread in southern Africa some occuring from Kwa-Zulu/Natal in the east to Namibia in the west. These include *Italochrysa impar, I. zulu* (Fig. 7), *Brinckochrysa pulchella* (also extends to Madagascar), *B. tjederi,* and *Chrysemosa commixta.*

Eighteen additional wide spread species were also recorded in the region.

Madagascan subregion

Thirty-one described species and subspecies are listed here. They are discussed by OHM and HÖLZEL (2002).

Wide spread in Africa and beyond

The enumerated 19 species do not fit well into the foregoing distribution patterns. They are wide spread over the whole region or at least over large parts of it. Some of them extend even further to other biogeographical regions. *Brinckochrysa chlorosoma* extends to the west up to the Cape Verde Islands, to the north over the whole Arabian peninsula into the Mediterranean to southern Europe. *Mallada desjardinsi* has also extended into the Cape Verdes, occurs in almost all countries of South and Central Africa and extends over all islands of the Madagascan subregion as far as the Bonin Islands in Micronesia. *Chrysoperla congrua* extends to St. Helen in the west, to Oman and Yemen in the north and over some islands of the Madagascan subregion to the Australian region in the east. The distribution of the other species is more or less limited to sub Saharan Africa and the Madagascan subregion.

This pattern of distribution is mainly found in families of the suborder Hemerobiiformia with larvae living on the vegetation (partly Chrysopidae, Hemerobiidae, Coniopterygidae). They usually do not colonise the lowland rainforest, but some have been recorded from there, *e.g. Ceratochrysa antica, Chrysoperla congrua, Dichochrysa sjoestedti* (Fig. 8), *Mallada desjardinsi.*

Poorly known Afrotropical Chrysopidae

Many of the12 species listed here were described almost 100 years ago and have not been recorded since then. In a few cases when type specimens are not available they will have to be removed from the list of Afrotropical Chrysopidae and be considered as nomina dubia

CONCLUSION

In this study a first attempt is made to arrange the known Afrotropical species of the family Chrysopidae into groups on the basis of their current distribution. The main constraint is that large parts of the continent have not been adequately investigated with respect to Chrysopidae. This concerns mainly West Africa where the fauna of the broad savannah belts north and south of the equatorial rainforest is virtually unknown. In 1966, BO TJEDER wrote in his monography of the South African fauna: "We know for the present not a single chrysopid from Angola". This has not changed. Likewise the fauna of the lowland rainforest as well as the fauna of the East African montane forests is scarcely known.

The degree of exploration is satisfactory only in southern Africa, where in the last decades many African and European entomologists have collected extensive material, which could be evaluated. Recent collections have also been made in West Africa on the Cape Verde Islands, in Senegal and in Equatorial Guinea, in East Africa in the Republic of Sudan and in Somalia. Our present knowledge about the Afrotropical elements in the fauna of the southern Arabian Peninsula is also very satisfactory (HÖLZEL 1998).

The attempt to arrange the Afrotropical species with respect to the patterns in their distribution is based on very differing numbers of records and some of the statements may prove to be only tentative.

*

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MUSCULATURE OF MALE GENITALIA OF ANTLIONS (NEUROPTERA, MYRMELEONTIDAE): FIRST RESULTS OF STUDY

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The male genitalia of species of antlions studied [*Myrmecaelurus trigrammus* (PALL.), *Creoleon plumbeus* (OL.)] consist of evident morpho-functional structures: pregenital, ejaculatory and copulatory complexes. The latter can be divided into the aedeagal and proctal subcomplexes. Sclerites and muscles of each complex are described.

Key words: antlions, male genitalia, musculature

MATERIAL AND METHODS

The present study was carried out on two species of antlions, *Myrmecaelurus trigrammus* (PALLAS, 1781), and *Creoleon plumbeus* (OLIVIER, 1811). Living specimens of both species were collected in the Kazantip Cape, Crimea, Ukraine, 25–28.07.1994 (V. KRIVOKHATSKY coll.) and preserved in 70% alcohol. The abdomens of 10–12 specimens of each species were dissected using microknifes and pins under the binocular microscope MBS-10 (LOMO, Russia). The drawings are schematic as the different parts of genitalia were viewed from a different angles and from a number of dissected specimens.

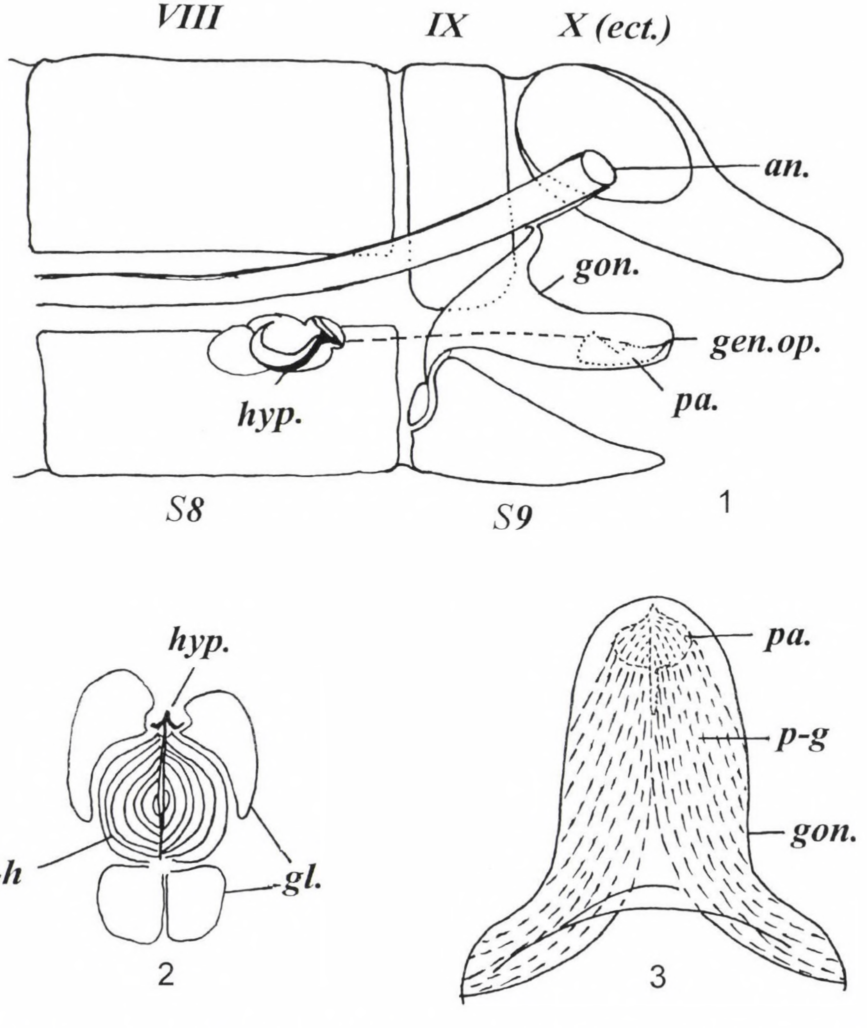
The terminology of sclerites in the male genitalia of antlions is given after TJEDER (1954, 1956), ACKER (1960), ASPÖCK *et al.* (1980); the different names for the same parts of genitalia of lacewings are used with contributions from the names known for other insect orders (SHVANVITSH 1949). The enumeration of muscles elaborated for well investigated taxa of insects, such as Diptera (OVTSHINNIKOVA 1989, 2000) and Lepidoptera (KUZNETZOV & STEKOLNIKOV 1984), is not used in the present preliminary report. Additional data from other taxa of antlions are needed for the correct enumeration in future.

RESULTS

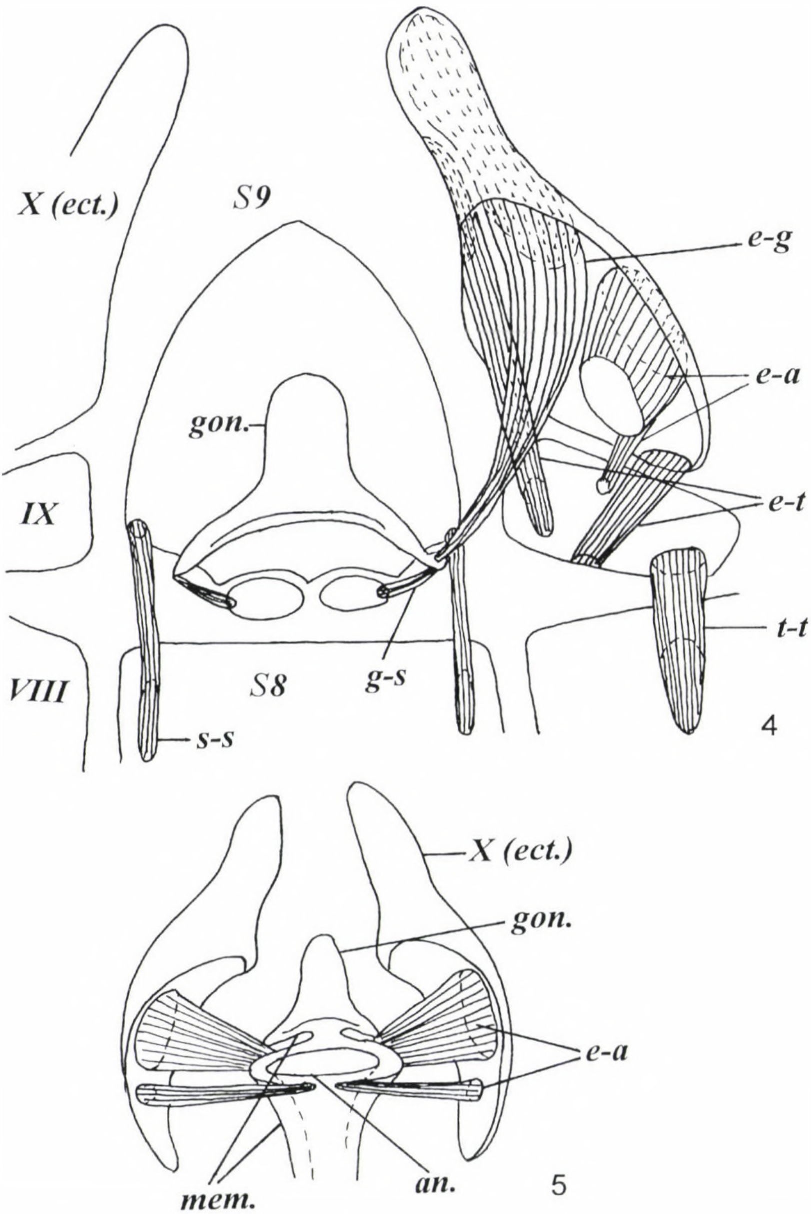
There are three well distinguished functional complexes of genital sclerites and their muscles in the tip of the abdomen in both species (Figs 1, 5): pregenital, ejaculatory, and copulatory. The latter can be divided into two subcomplexes: aedeagal and proctal.

Ejaculatory complex

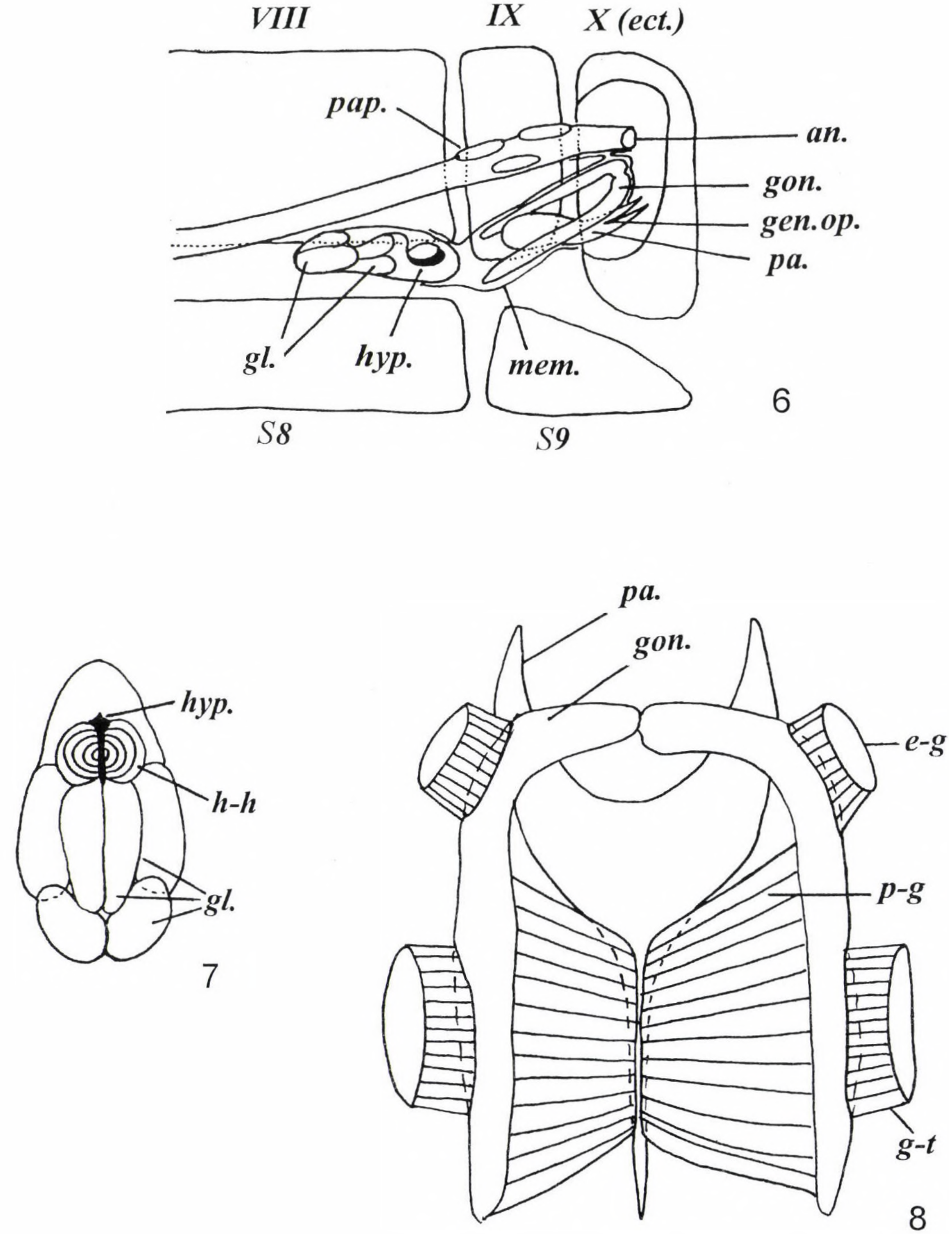
Ejaculatory complex consists of the ejaculatory apodeme (*hyp.* – hypandrium internum or sternite 10) with strong muscles *h–h* (Figs 2, 7), which pump



Figs 1–3. Internal male genitalia structures of *Myrmecaelurus trigrammus*: 1 = general structure of internal genitalia, lateral view; 2 = ejaculatory complex, dorsal view; 3 = aedeagal subcomplex, dorsal view. Explanations: VIII = eight abdominal tergite, IX = ninth abdominal tergite, X (ect.) = tenth abdominal tergite (ectoproct); an. = anus; gen. op. = genital opening; gl. = glands; gon. = gonarcus; hyp. = hypandrium internum; h–h = muscle hypandrium–hypandrium; pa. = paramere; p–g = muscle paramere–gonarcus; S8 = eight sternite; S9 = ninth sternite



Figs 4–5. Internal male genitalia structures of *Myrmecaelurus trigrammus*: 4 = musculature of pregenital and copulative complexes, dorsal view; 5 = proctal subcomplex, dorsal view. Explanations: e–a = muscle ectoproct–anus; e–g = muscle ectoproct–gonarcus; e–t = muscle ectoproct–ninth tergite; g–s = muscle gonarcus–ninth sternite; mem. = membrane; t–t = eight tergite – ninth tergite; others as as in Figs 1–3



Figs 6–8. Internal male genitalia of *Creoleon plumbeus*: 6 = general structure of internal genitalia, lateral view; 7 = ejaculatory complex, dorsal view; 8 = aedeagal subcomplex, dorsal view; Explanation: p–g = paramere–gonarcus; others as in Figs 1–3 and 4–5

sperm to the aedeagal subcomplex. The ejaculatory apodeme has no muscles connected with other sclerites. This complex is very compact and includes also two or more pairs of different sexual glands (*gl.*). The sickle-like plate of the hypandrium internum is present in both species. This plate is membranous and slightly reddish coloured in fresh alcohol preparations. It is invisible on preparations after boiling in KOH (potassium hydroxide) solution and was not found previously in *M. trigrammus* or in *C. plumbeus*. Some time ago the presence or absence of the hypandrium internum was estimated by me as the diagnostic feature in the generic

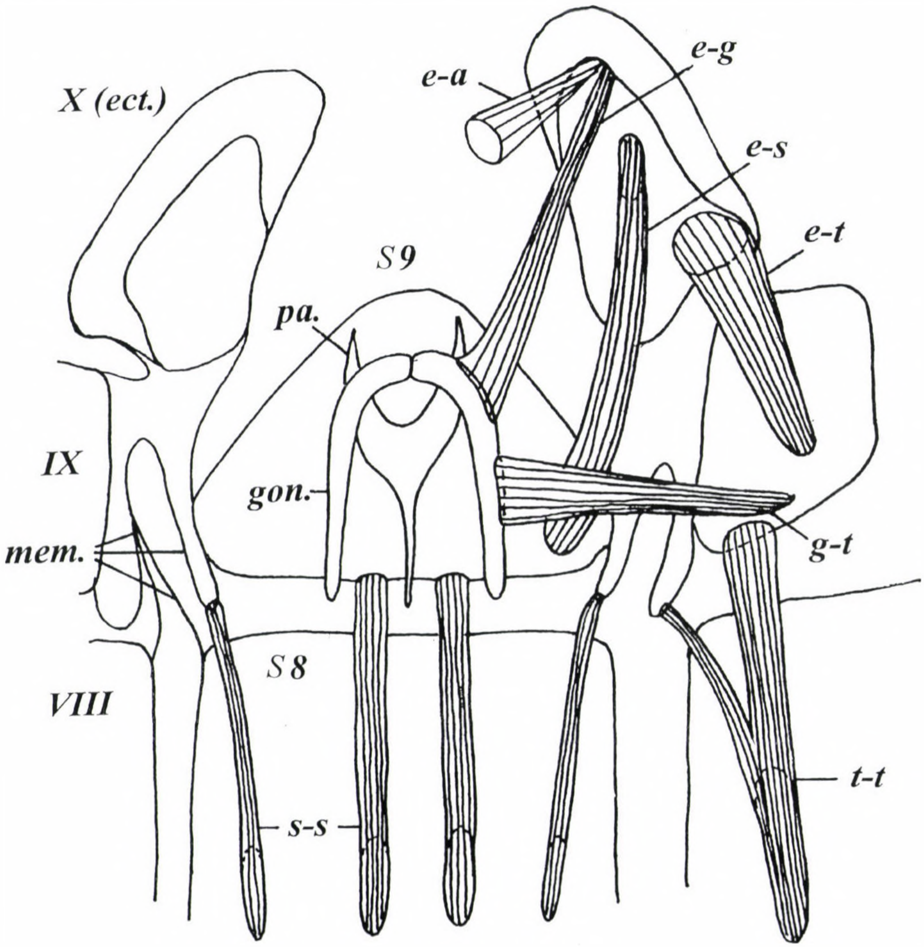


Fig. 9. *Creoleon plumbeus:* musculature of pregenital and copulative complexes, dorsal view. Explanations: e–s = muscle ectoproct–ninth sternite; s–s = muscles eight sternite–ninth sternite; others as in Figs 1–3 and 4–5

level in Myrmecaelurinae (KRIVOKHATSKY 1992); moreover it was not found in all taxa with nemoleontine type of male genitalia. It now seems, that the hypandrium internum should be found in genitalia of almost all species of Myrmeleontidae, as they should have a structure with ejaculatory function.

Pregenital complex

Pregenital complex supports inner genitalia (aedeagal complex) within the abdomen by means of tergal (*t–t*) and sternal (*s–s*) muscle pairs (Figs 4, 9) connecting tergites VIII and IX and sternites 8 and 9 by the same manner as in previous abdominal segments. In that complex some differences between the species were found. While in *M. trigrammus* its muscles are simple (Fig. 5), in *C. plumbeus* (Fig. 9) they are splitt. Sternal muscles in *C. plumbeus* are splitt into the two distinctive pairs, one of which runs from the middle of sternite 8 to the basal edge of sternite 9, and the other one from the middle of sternite 8 (some laterally) to the wide membrane close to the lateral corners of sternite 9. Tergal muscles in *C. plumbeus* are bifurcated; the stronger branch attaches to the basal part of tergite IX, and the smaller one to the same membrane, but close to the basal corner of tergite IX.

Copulative complex

Copulative complex functions as the aedeagus (copulatory and sperm-pump functions) and prohibitor of defecation during copulation.

Aedeagal subcomplex – The aedeagal subcomplex in both species (Figs 1, 6) consists of gonarcus (*gon.*, coxopodite 9) and paramere (*pa.*, coxopodite 10). These sclerites connect with each other by means of strong muscles *p–g* (Figs 3, 8), which move the paramere into the gonarcus. Other muscles responsible for the movement of gonarcus differ considerably in two species. *C. plumbeus* (Figs 8, 9) has more simple construction with gonarcus supplied by one pair of protractors of gonarcus *e–g* (from gonarcus to ectoproct) and one pair of retractors *g–t* (from gonarcus to tergite IX). Protractors of gonarcus *e-g* in *M. trigrammus* (Fig. 4) are also well defined, but retraction is carried out by the muscles *g-s* running from the corners of gonarcus to the basal plates of sternite 9. Some other muscles (*e–a*) take part in the movement of gonarcus too, but their primary function seems to be different.

Proctal subcomplex – Proctal subcomplex has the role to block the anus during copulation, and consists of muscles *e–a* compressing the integument of anus when aedeagal complex is protracted (Fig. 5). In *M. trigrammus* (Figs 4, 5) there are two pairs of *e–a*. Both are responsible for the opening of ectoprocts and for

compressing the anus during copulation. More strong pair of *e–a* runs from the gonarcus and attaches to the integument of anus close to the gonarcal membrane. It takes part in pulling out the gonarcus. More slender pair of *e–a* attaches to the anus from above. The latter was found in *C. plumbeus* (Fig. 9), where the strong pair was not found. It seems that the blocking function is realized from below by *e–g* muscles which press the arc of gonarcus to the integument of anus. The muscles of the proctal complex, which function to block the anus during copulation, also take a definite part in the process of defecation at other times.

*

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Catalogue of Palaearctic Diptera

edited by Á. SOÓS, L. PAPP and P. OOSTERBROEK

Volume 1
Trichoceridae – Nymphomyiidae

The Catalogue contains the basic taxonomic, nomenclatorial and distribution data of all species occurring in the Palaearctic Region with the fundamental morphological features for the majority of the fly groups.

Contents: Introduction to Volumes 1–13 (Á. SOÓS and L. PAPP). History of the Catalogue of Palaearctic Diptera. Structure. Genera and their type-species. Species names, type-localities. Distribution. Literature data, references. Dates of publication. Readers. Acknowledgements and closing remarks. List of contributors (Vols 1–13). Type-species designations in Volume 1. New names proposed in Volume 1. Families: Trichoceridae (C. DAHL). Tanyderidae (R. WAGNER). Blephariceridae (P. ZWICK). Deuterophlebiidae (L. JEDLIČKA). Tipulidae (P. OOSTERBROEK and BR. THEOWALD). Cylindrotomidae (Á. SOÓS and P. OOSTERBROEK). Limoniidae (E. N. SAVCHENKO, P. OOSTERBROEK and J. STARY). Ptychopteridae (R. ROZKOŠNÝ). Nymphomyiidae (L. JEDLIČKA). Bibliography. Index.

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NEUROPTERIDA OF THE ABRUZZO NATIONAL PARK, ITALY

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A preliminary check list of Neuropterida of Abruzzo National Park, Italy, is presented. About 49 taxa of Megaloptera, Raphidioptera, and Neuroptera were detected within the Park and in the surrounding areas, although the identity of 13 of these requires confirmation. The material was collected during occasional research between 1997 and 1999. A review of publications with distributional data is included.

Key words: Abruzzo National Park, Megaloptera, Raphidioptera, Neuroptera, Italy

INTRODUCTION

Dr. F. TASSI (Abruzzo National Park) started Biodiversity Project in 1993. This project is one of the new lines of conservation activity, environmental education and scientific research of the Abruzzo National Park and its satellite organizations, and in particular of the Apennine Centre for Ecological Research and of the National Parks Committee. Biodiversity Project sets itself a series of multiple aims:

I. Promoting in-depth studies and knowledge of the richness, variety and status of the fauna and flora of the Park, of the Central Apennine system of protected areas and, in a wider perspective, of the rest of Italy, with special reference to the National Parks and Equivalent Reserves.

II. Developing the most effective methods of communication, expression and information to enhance public knowledge, perception and participation in conservation activities.

III. Identifying priorities, strategies and tactics, and therefore the most appropriate policies, for full attainment of the fundamental aims of conservation.

More than 7 000 different animal and plant species have been recorded in the Abruzzo National Park and in its Buffer Area to date.

Biodiversity Project pursues its objectives through the most varied actions. One of these is the compilation of lists (Red List, Check List, other historical and/or updated lists) of the living organisms of well-defined geographical zones.

ABRUZZO NATIONAL PARK

The Abruzzo National Park, consisting of 50 000 hectares (plus 60 000 hectares of buffer zone), is situated at the heart of the central Apennines, spanning Abruzzo, Lazio and Molise, and equidistant from the Adriatic and the Tyrennian seas.

The Park covers three provinces (Aquila, Frosinone and Isernia), and twenty-two municipalities, and includes five distinct geographical areas: Alto Sangro, Marsica Fucenese and the Peligna valley in Abruzzo; the Comino valley in Lazio; the Mainarde in Molise.

The Park is principally made up of several mountain chains, rising from an altitude of 900 to 2 000 metres a.s.l. The landscape is varied and interesting, alternating between rolling hilltops, typical of the Apennines, to precipitous alpine slopes.

The Sangro river runs through the centre of the Park, and has several streams running into it, whilst the waters of the Giovenco, Melfa, Volturno and other rivers flow through the external part of the Park. Because of the karst phenomenon, rivers often flow through underground beds and rise to the surface in the valleys, sometimes outside the territory of the Park.

Inside the protected area there is only one small natural basin at high altitude. This is Lake Vivo, fed partly by its own springs and partly by melted snow.

The Park's territory was formed in the past by the phenomena of glaciers and karst, or rough limestone. Today we can see evidence of this in the glacial circles found in the high parts of the valleys, and morainic deposits and jagged rocks on the valley floors. The karst phenomenon can be seen by the presence of caves, fissures, holes and other similar features.

The rocks in the park are calcareous; clayey and sandy soils can be found only in the lower parts of some valleys. The mountain chain of Camosciara is typical of the region, which also comprises dolomitic limestone. The impermeable rocks cause the water to flow along the surface, and as a result we can find torrents which form picturesque waterfalls and pools.

CHECKLIST OF NEUROPTERIDA OF ABRUZZO NATIONAL PARK

MEGALOPTERA

Sialidae

Sialis fuliginosa PICTET, 1836
Sialis lutaria (LINNÉ, 1758)
Sialis nigripes PICTET, 1865

RAPHIDIOPTERA

Raphidiidae

Phaeostigma galloitalica (H. ASPÖCK et U. ASPÖCK, 1976)

Ornatoraphidia flavilabris (COSTA, 1855)

Inocelliidae

* *Parainocellia bicolor* (A. COSTA, 1855)

NEUROPTERA

Coniopterygidae

* *Helicoconis pseudolutea* OHM, 1965

* *Coniopteryx tineiformis* CURTIS, 1834

Coniopteryx arcuata KIS, 1965 ?

* *Coniopteryx esbenpeterseni* TJEDER, 1930

Coniopteryx lentiae H. ASPÖCK et U. ASPÖCK, 1964 ?

Semidalis aleyrodiformis (STEPHENS, 1836)

Mantispidae

Mantispa styriaca (PODA, 1761) ?

Perlamantispa perla (PALLAS, 1772) sensu ERICHSON, 1839 ?

Hemerobiidae

* *Hemerobius gilvus* STEIN, 1863

* *Hemerobius handschini* TJEDER, 1957

Hemerobius humulinus LINNÉ, 1758 ?

* *Hemerobius micans* OLIVIER, 1792

Hemerobius nitidulus FABRICIUS, 1777

* *Hemerobius stigma* STEPHENS, 1836

Wesmaelius tjederi (KIMMINS, 1963) ?

Megalomus hirtus (LINNÉ, 1761) ?

Megalomus pyraloides RAMBUR, 1842 ?

Megalomus tineoides RAMBUR, 1842 ?

* *Megalomus tortricoides* RAMBUR, 1842

* *Micromus paganus* (LINNÉ, 1767)

Chrysopidae

Chrysopa dorsalis BURMEISTER, 1839

Chrysopa pallens (RAMBUR, 1838)

Chrysopa perla (LINNÉ, 1758) sensu SCHNEIDER, 1851

Chrysopa viridana SCHNEIDER, 1845 ?

Chrysopa walkeri MCLACHLAN, 1893

Chrysoperla carnea s.l. (STEPHENS, 1836)

* *Chrysoperla lucasina* (LACROIX, 1912)

* *Chrysoperla* «slow motorboat» sensu HENRY

* *Chrysopidia ciliata* (WESMAEL, 1841)

Cunctochrysa albolineata (KILLINGTON, 1935)

Cunctochrysa baetica HÖLZEL, 1972 ?

Dichochrysa flavifrons (BRAUER, 1850)

Dichochrysa sp.pr. *picteti* (MCLACHLAN, 1880)
Dichochrysa prasina (BURMEISTER, 1839)
Dichochrysa ventralis (CURTIS, 1834)
Nineta flava (SCOPOLI, 1763)
* *Hypochrysa elegans* (BURMEISTER, 1839)

Myrmeleontidae
Acanthaclisis occitanica (VILLERS, 1789) ?
* *Myrmeleon formicarius* LINNÉ, 1767

Ascalaphidae
Libelloides coccajus (DENIS et SCHIFFERMÜLLER, 1775)
Libelloides italicus (FABRICIUS, 1781) ?
Libelloides longicornis (LINNÉ, 1764)
Libelloides ottomanus (GERMAR, 1817)

The systematic order used derives from the checklist of Italian Neuropterida (BERNARDI *et al.* 1995) with few modifications; "*" symbol indicates species collected in this area for the first time; "?" symbol indicates determination which needs confirmation.

DISCUSSION

With the exception of a scientific surveying lead from the Institute of Entomology of Bologna (GRANDI 1958; PRINCIPI 1958b), no other specific study on the Neuropterida has been realized in the territory of the Park until today. In that previous study, 13 species were reported, pertaining to the families Chrysopidae, Hemerobiidae and Ascalaphidae.

In numerous other papers (NAVAS 1928, CASTELLANI 1957, PRINCIPI 1958*a*, 1977, INSOM *et al.* 1979, 1985, AISTLEITNER 1980, ASPÖCK *et al.* 1980, 1991, LETARDI 1991, 1994, ZUPPA 1994, LETARDI & PANTALEONI 1996, PANTALEONI & LETARDI 1998) several faunistic reports concerning Neuropterida in the territory of the Park have been published. In three years, from 1997 to 1999, a series of collections of Neuropterida have been made, using a sweep net, in several areas of the Park at different periods during the year, with the aim of updating the "Check List of the living organisms" previewed in the Biodiversity Project of the Park.

Based on such studies, at the moment 49 taxa comprising 9 families (Sialidae, Raphidiidae, Inocelliidae, Coniopterygidae, Mantispidae, Hemerobiidae, Chrysopidae, Myrmeleontidae, and Ascalaphidae) are reported in the checklist; 13 of these are reported as "uncertain" for various reasons. In particular, records of *Coniopteryx arcuata*, *C. lentiae*, *Hemerobius humulinus*, *Wesmaelius tjederi*, *Megalomus hirtus*, *M. pyraloides*, *M. tineoides*, *Chrysopa viridana*, *Cunctochrysa baetica*, and *Libelloides italicus* are based on bibliographical references with indica-

tion of locality not attributable with absolute certainty to the territory of the Park. For Mantispidae, a reliable visual report exists (PACE pers. comm.) which does not allow for an undoubtful species attribution (both *Mantispa styriaca* and *Perlamantispa perla* are quite common in different areas of Abruzzo with similar environmental conditions which can be found in the Park). Finally, the report of *Acanthaclisis occitanica* for the Park is based on a specimen preserved in a reliable collection, but the ecological requirements of such species are not compatible with present environments in the Park.

The resulting Neuropterofauna is probably complete enough, taking into consideration the different environments in the territory of the Park. However, we can not exclude the possibility that further research, carried out with other techniques of collection (in particular with light traps), will increase the number of both species and families, in particular within Coniopterygidae and Hemerobiidae.

*

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A WEB PAGE ON ITALIAN NEUROPTERIDA

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For several reasons, very few researchers devoted their studies to Italian Neuropterida. One of these motives was difficulty in literature searches due to the lack of a review of many data scattered in obscure journals and publications. Internet tools can assist researchers to communicate and easily find and access information. This contribution introduces the present "state of the art" regarding a web catalogue of data pertaining to Italian Neuropterida.

Key words: Internet site, Neuropterida, Italy

INTRODUCTION

Acceptance of the Internet as a common method for transferring entomological information has brought about a re evaluation of the role of extension entomology, i. e. all the strategies of distributed information systems in this field. New opportunities exist for the collection and sharing of knowledge, but the organization and categorization of information for timely retrieval remains a challenge (VANDYK 2000).

Researchers benefit from using the Internet on a one-to-one basis (e-mail, File Transfer Protocol), a one-to-many basis (discussion groups, Internet conferences), and from accessing large databases of knowledge. The constraints of time and money to accumulate and continually update entomological knowledge is significant, but the cost of posting large databases on the Web is relatively small (ZENGER & WALKER 2000).

Information on most Italian Neuropterida is scattered in obscure journals and publications, making literature searches difficult and discouraging researchers from studying this taxon. Since Neuroptera-L – the Neuroptera listserver managed by PETER MCEWEN – and Neuroweb – the web site of resources managed by JOHN OSWALD – were established in 1995 and 1996, respectively, it has been clear that the Internet could play an important role in facilitating the tasks of researchers who study this group of insects (MCEWEN & OSWALD 1998).

Since 1988, the present author has accumulated much information on Italian Neuropterida (bibliographic references, data from public and private collection, biological and zoogeographical notes and illustrations), both for personal neuropterological studies and for sharing information with colleagues.

After collaboration started in early 1998 on the project "Bibliography of the Neuropterida" to update the on-web bibliography with Italian literature, it was decided to post most of these data on a website.

Some of these "pages under construction" which will be put on web are introduced here.

CONTENT OF THE WEB PAGE

In the first release of this "home page" of the Italian Neuropterida, four groups of data will be provided:

1) A bibliographical listing of collection data on Italian Neuropterida with:

– bibliographic references;
– original and updated determination;
– Italian region;
– year of capture of specimen (if data is available).

2) A scheme with the regional distribution within Italy and adjoining regions of taxa (Fig. 1).

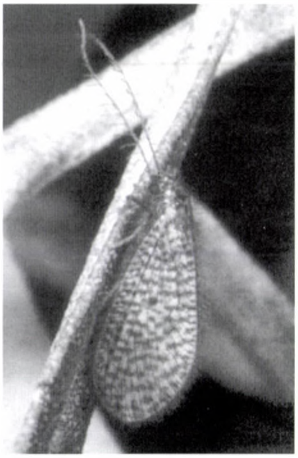
	Valle d'Aosta	Piemonte	Lombardia	Trentino Alto Adige	Veneto	Friuli Venezia Giulia	Liguria	Emilia Romagna	Toscana	Umbria	Marche	Lazio	Abruzzo	Molise	Campania	Basilicata	Puglia	Calabria	Sicilia	Sardegna	is. Elba	is. Ponziane	is. Eolie	is. Egadi	is. Tremiti	is. Pantelleria	isole minori	Corsica	Vallese	Grigioni	Ticino	Malta	Istria	Slovenia	Croazia	Alpi Marittime Francesi	altro
Sialis fuliginosa Pictet			?		?						?																										
Sialis lutaria (Linnaeus)									?		?						?																				
Sialis morio Klingstedt																																					
Sialis nigripes Pictet																																					Svizzera meridionale
Phaeostigma (s.str.) galloitalica (A. & A.)														?																							
Phaeostigma (s.str.) italogallica (A. & A.)																																					
Phaeostigma (s.str.) notata (F.)																	?																				
P. (Pontoraphidia) grandii (Principi)																																					
Magnoraphidia major (Burmeister)						?																															
Dichrostigma flavipes (Stein)							?												?																		
Tjederiraphidia santuzza A., A. & R.																																					
Subilla confinis (Stephens)	?					?																															
Ornatoraphidia etrusca (Albarda)										?				?																							
Xanthostigma xanthostigma Schummel	?	?				?																						?									
Xanthostigma corsica (Hagen)																											Giglio										
Xanthostigma aloysiana (Costa)	?																																				
Raphidia ophiopsis Linnaeus																																					
Raphidia mediterranea A., A. & R.					?			?	?		?				?	?			?																		
Raphidia ulrikae Aspöck																																					
Raphidia ligurica Albarda							?																														
Atlantoraphidia maculicollis Stephens		?																																			
Italoraphidia solariana (Navás)																																					
Puncha ratzeburgi (Brauer)																																					
Venustoraphidia nigricollis Albarda	?	?																																			
Fibla maclachlani (Albarda)																		?									S.Pietro ?										
Parainocellia braueri (Albarda)																																					
Parainocellia bicolor (Costa)																																					
Inocellia crassicornis (Schummel)																																					Tirolo
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Fig. 1. Detail of regional distribution scheme for the Italian Neuropterida on the upcoming web page

3) A collection of literature containing data on Italian Neuropterida, that can be downloaded as pdf (Portable Document Format) file.

4) A card for each taxon with biological, faunistic, morphological and taxonomical notes (Fig. 2).

Dilar parthenopaeus **Costa, 1855**



Maschio adulto (Foto Lentini)



Femmina adulta (Foto Pantaleoni)

Specie dalle caratteristiche ecologiche pressoché sconosciute. Raccolta in Italia in querceti misti di bassa quota, in lecceta e sul limite superiore della vegetazione, tra i 300 e i 1700 m. nel periodo luglio - metà agosto (Letardi, 1994b,c; Pace, comm. pers.).

Endemismo italiano

Locus typicus italiano: Monti della Cava [prob. Cava de' Tirreni], Campania

Stadi preimmaginali: sconosciuti.

Ampiezza dell'ala anteriore delle immagini: da 4,5 a 6,5 mm. i ? ? (Aspöck H., Aspöck U., Hölzel U., 1980); 4 mm. le ? ? (ali modificate, inabili al volo, ali posteriori vestigiali di 0,5 mm. ca.; Pantaleoni e Letardi, 1996).

Distribuzione regionale italiana:

Lazio; Campania; Basilicata; Calabria; Sicilia?; Sardegna?

Pubblicazioni che citano questa specie in Italia:

Costa, 1855; Brauer, 1876; Costa A., 1884b; Hagen, 1860a; Hagen, 1866; Navás, 1909; Navás, 1910; Navás, 1914; Grandi, 1951; Aspöck et al., 1980; Letardi, 1994b; Letardi, 1994c; Bernardi Iori et al., 1995; Pantaleoni & Letardi, 1996; Aspöck U. & H., 1999;

Fig. 2. Example card for a specific taxon of Italian Neuropterida on the upcoming web page

Further information, and links with other web resources pertaining to Italian Neuropterida, will be added during the updating of this first contribution to the sharing of knowledge about these insects.

CONCLUSION

Between the end of 2000 and the beginning of 2001 this "home page" of the Italian Neuropterida will be included in the frame of the home pages of the Civic Museum of Zoology of Rome.

In future, when more sophisticated tools become available, it will be possible to generate online information. At the moment, this contribution represents another, uncategorized source of entomological information, but hopefully this tool will help the Italian research community towards a more common sharing of knowledge about this small, but important group of insects.

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REMARKS ON NEUROPTERA OF NORTH-EASTERN SLOVENIA (GORIČKO)

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The abundance of species of Neuroptera was studied in the traditional cultural landscape of Goričko (NE Slovenia). The insects were collected during 1997, 1998 and 1999 at 12 different localities. The green lacewing *Chrysoperla carnea* sensu lato was the most dominant species in the region. This species was the only one found in cultivated fields in Goričko district.

Key words: Neuroptera, Goričko, Slovenia

INTRODUCTION

The north-eastern part of Slovenia (Goričko) is known to be one of the best preserved and undamaged natural habitats of our country because of its traditional farming. This region is mainly influenced by Central-European and Pannonian climates, and is a very interesting natural area. However, no study has been made of its neuropteran fauna. Preservation of Goričko makes its fauna of special interest to us. The aim of this study was therefore to provide preliminary information on the presence and distribution of different Neuroptera in Goričko.

MATERIALS AND METHODS

Neuroptera were investigated at 12 different localities in Goričko: Ledavsko lake (1), Kuzma (2), Grad (3), Vidonci (4), Mačkovci (5), Stanjevci (6), Čepinci (7), Markovci (8), Bokrači (9), Križevci (10), Krplivnik (11) and Hodoš (12). These numbered localities are indicated in Fig. 1. Nine sites (1, 3, 5, 6, 8–12) were natural habitats, representing typical vegetation of Goričko. They included (a) forests comprising chestnut (*Castanea sativa*), trembling poplar (*Populus tremula*), alder (*Alnus glutinosa*), beech (*Fagus sylvatica*), oak (*Quercus petraea*) and pine (*Pinus sylvestris*), (b) meadows and (c) edges of forests. The other three sites (2, 4 and 7) included agricultural surfaces, e.g. meadows located between fields. The results presented here were obtained in July 1997, June and July 1998 and from May to August 1999. Larvae and adults were collected twice a month with a net, by beating branches of bushes and trees over an umbrella, by picking the larvae from the field and at night with light traps using the bulb with tungsten filament.

RESULTS AND DISCUSSION

Species of the following families were found: Coniopterygidae, Osmylidae, Sisyridae, Mantispidae, Hemerobiidae, Chrysopidae, Myrmeleontidae and Ascalaphidae. The results are shown in Table 1.

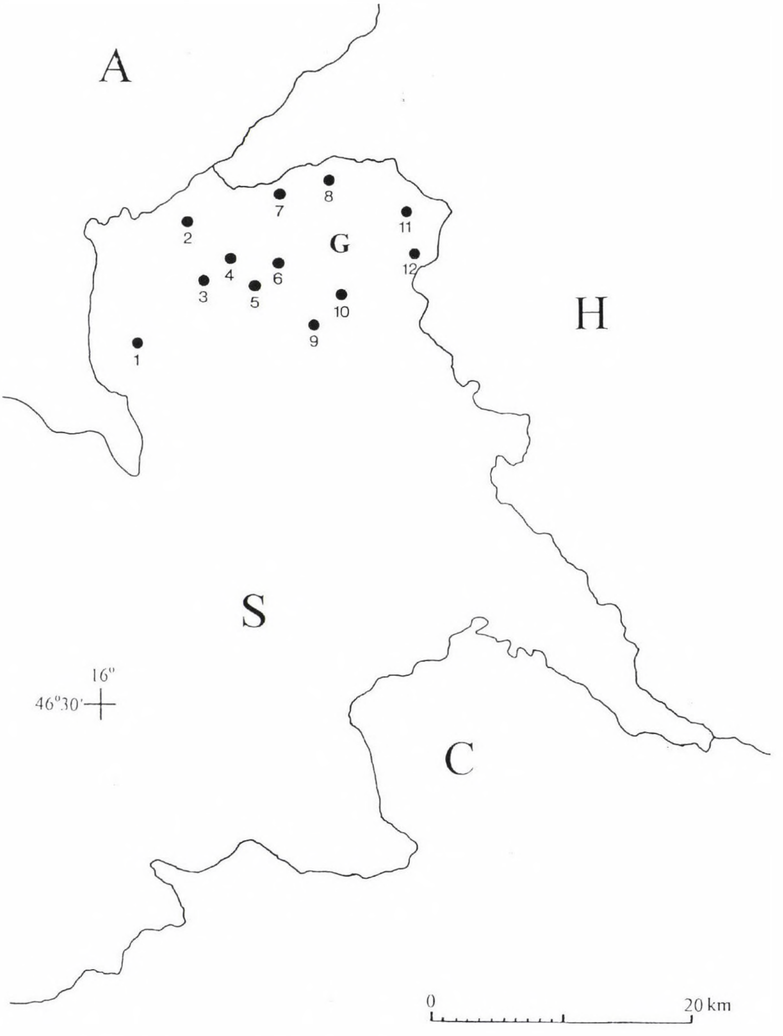


Fig. 1. A map of Goričko with collecting sites. Abbreviations: 1 = Ledavsko lake, 2 = Kuzma, 3 = Grad, 4 = Vidonci, 5 = Mačkovci, 6 = Stanjevci, 7 = Čepinci, (= Markovci, 9 = Bokrači, 10 = Križevci, 11 = Krplivnik, 12 = Hodoš, S = Slovenia, G = Goričko, A = Austria, H = Hungary, C = Croatia

All of recorded species of Neuroptera in Goričko are also present in other parts in Slovenia and have been studied by DEVETAK (1984, 1992). Similar studies have been carried out in Austria (HÖLZEL *et al.* 1980) and in Hungary (SZIRÁKI *et al.* 1992).

Table 1. List of species of Neuroptera collected in Goričko. The numbers in the right part of the table indicate localities (see Material and methods) in which Neuroptera were found. The presence of Neuroptera in agricultural sufraces was investigated in Kuzma, Vidonci and Čepinci (localities 2, 4 and 7). The other 9 sites were natural habitats representing typical vegetation of the Goričko area

	1	2	3	4	5	6	7	8	9	10	11	12
Coniopterygidae												
Coniopteryx pygmaea ENDERLEIN, 1906											*	
Semidalis aleyrodiformis (STEPHENS, 1836)							*	*				
Aleuropteryx loewii KLAPALEK, 1894							*					
Osmylidae												
Osmylus fulvicephalus (SCOPOLI, 1763)							*				*	
Sisyridae												
Sisyra terminalis CURTIS, 1854	*											
Mantispidae												
Mantispa styriaca (PODA, 1761)						*		*				
Hemerobiidae												
Hemerobius (H.) micans OLIVIER, 1792			*	*	*		*	*	*			*
Hemerobius (H.) lutescens FABRICIUS, 1793					*							
Hemerobius (H.) humulinus LINNAEUS, 1758							*					
Hemerobius (H.) handschini TJEDER, 1957							*					
Hemerobius (Brauerobius) marginatus STEPHENS, 1836					*				*			
Drepanepteryx phalaenoides (LINNAEUS, 1758)							*					
Micromus variegatus (FABRICIUS, 1793)							*					
Micromus angulatus (STEPHENS, 1836)							*					
Chrysopidae												
Chrysoperla carnea (STEPHENS, 1836) sensu lato	*	*	*	*	*		*	*	*	*	*	*
Chrysopa perla (LINNAEUS, 1758)		*		*	*		*	*		*	*	
Myrmeleontidae												
Euroleon nostras (GEOFFROY in FOURCROY, 1785)			*					*				
Dendroleon pantherinus (FABRICIUS, 1787)								*				
Ascalaphidae												
Libelloides macaronius macaronius (SCOPOLI, 1763)							*					
Total number of species collected	2	2	3	3	5	1	12	7	3	2	4	2

The green lacewing *Chrysoperla carnea*, treated here in the accepted sense of the "complex", was the dominant neuropteran with respect to the number of specimen collected in Goričko region. BROOKS (1994) recognized four distinct species groups within *Chrysoperla*-complex, based on morphology of the male genitalia and wings. Recently, 5 sibling species were recognized within the *carnea*-group of *Chrysoperla* based on their distinctive vibrational courtship songs (HENRY *et al.* 1996). These green lacewings, present in 11 investigated localities and absent only from Stanjevci (locality 6), are of great importance as a natural aphid enemies. The presence of *Chrysoperla carnea* is expected also in Stanjevci, but its absence in our list may be the consequence of the lack of sufficient collecting data. Therefore its presence in Stanjevci should be checked in the near future. *Chrysoperla carnea* was the only neuropteran species found in some cultivated fields (e. g. fields of cereals). In the contrary, *Mantispa styriaca* inhabited only natural areas, e.g. forest edges. Also *Coniopteryx pygmaea, Sisyra terminalis, Hemerobius lutescens, H. marginatus, Euroleon nostras* as well as *Dendroleon pantherinus* were present only in natural habitats.

Chrysopa perla is the second most abundant species found in Goričko. It was present on 7 different localities, as *Hemerobius micans.*

Neuroptera showed the highest number of species (12) in Čepinci (locality 7). Such result has not come entirely as a surprise. This agricultural surface borders on the forest edge, therefore a relatively high number of species was expected there. A higher number of species at forest edges than at other areas appears to be the rule rather than exception, as was also shown in the study assessing the contribution of forest ecotone structures to regional biodiversity, presented by DUELLI *et al.* (2002).

The focus of our work was on survey of different neuropteran species in Goričko. As there are some rare and endangered species of Neuroptera (*e. g. Osmylus fulvicephalus*, *Mantispa styriaca* and *Libelloides macaronius*) in Goričko, this part of Slovenia should receive greater concern of nature-conservation organisations. As different other neuropteran species are expected in Goričko, we intend to continue our research of Neuroptera in this region.

*

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Catalogue of Palaearctic Diptera

edited by Á. SOÓS and L. PAPP

Volume 13
Anthomyiidae – Tachinidae

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Contents: Explication to distribution. Type-species designations in Volume 13. New names proposed in Volume 13. Families: Anthomyiidae (Á. DELY-DRASKOVITS). Rhinophoridae (B. HERTING). Tachinidae (B. HERTING and Á. DELY-DRASKOVITS). Bibliography. Index.

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MONITORING LACEWINGS (INSECTA: NEUROPTERA) IN SOUTHERN AFRICA

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A concerted research programme is being undertaken on southern African Neuroptera. This has been formally structured into five operational components or focal areas: a biodiversity audit, systematic revisions, study of larval biology and ecological requirements, distribution patterns and predictive modelling, and conservation status and protective measures. The programme is being undertaken in collaboration with local and international researchers, while amateur entomologists also make significant contributions.

Key words: Southern Africa, Neuroptera, ecology, biogeography, predictive modelling, conservation

INTRODUCTION

Southern Africa has an especially rich and varied fauna of lacewings (Insecta: Neuroptera), including 12 of the 17 recognised families. Approximately 500 species are estimated to occur in the region south of the Cunene and Zambezi rivers. About half of these are endemic to the sub-region, but they are vulnerable to habitat fragmentation and pesticide contamination. Neuroptera are consequently excellent indicators of environmental and habitat transformation, and also include key species for signifying areas and faunas that require priority protection. They are ideal subjects for scientific research owing to their diverse and cryptic lifestyles, and because of the restricted distributions and phenology of endemic species. Adults of several families pollinate indigenous flora, with Nemopteridae being particularly significant in this regard. All larvae are specialised predators with unique, highly evolved mouthparts that clearly delimit Neuroptera as a monophyletic group. Because of their predatory habits, lacewing larvae impact upon populations of other insects and small Arthropoda, and are sought after as biological control agents.

A research programme to document and monitor the rich but vulnerable fauna of southern Africa is in progress, and involves both local and international collaborators. The stimulus for this concerted research effort was provided by the classic studies of BØ TJEDER (1957, 1959, 1960, 1966, 1967), who laid the founda-

tions to neuropterology in southern Africa and, in the process, posed many challenging questions to his successors.

The programme has five main objectives (Fig. 1): (1) a biodiversity audit, (2) systematic revisions, (3) elucidation of larval biology and ecological requirements, (4) distribution patterns and predictive modelling, (5) conservation status and protective measures. These areas have been identified to focus research on southern African lacewings into a formal structure with clearly defined goals.

THE BIODIVERSITY AUDIT

This aspect is fundamental to the other focus areas, its main objective being to determine which taxa occur in southern Africa. It involves ongoing collecting in all areas of the sub-region, as well as recording historical data from specimens in collections, locally and abroad.

Adult Neuroptera are collected by means of non-destructive light-traps (OBERPRIELER 1984) and by beating and sweeping vegetation. All material is pinned, and collection data are entered into the "*Palpares* Relational Database" that was designed for this purpose (MANSELL & KENYON 2002). Specimens are housed in the South African National Collection of Insects (SANC) and in other public and private collections. There are currently 31 000 specimens of Neuroptera in SANC, accommodated in 12 cabinets comprising 480 drawers. .

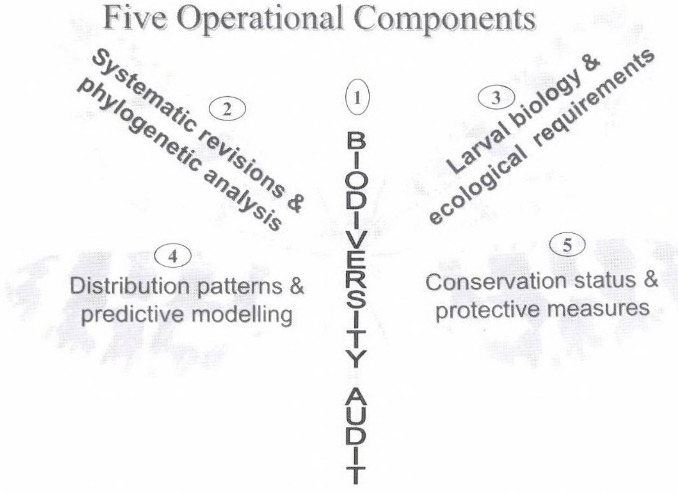


Fig. 1. Diagram of the main focus areas of the Southern African Lacewing Monitoring Programme

Many persons, whose names are recorded in the database, have collected and donated specimens to the programme. This is an important source of data, and several have made significant contributions to our knowledge of southern African Neuroptera. Field work by SANC personnel has yielded many specimens, while recent collaborative expeditions with overseas and local colleagues have considerably enhanced collection holdings of Neuroptera. These collaborators include, H. ASPÖCK, U. ASPÖCK, H. HÖLZEL (Austria), P. OHM (Germany), R. B. MILLER, L. A. STANGE, J. D. OSWALD (U.S.A.), and L. R. MINTER. M. D. PICKER and C. H. SCHOLTZ (South Africa). The 1988 excursions that followed the Third International Symposium on Neuropterology also yielded a significant list of southern African Neuroptera (MANSELL & ASPÖCK 1990).

SYSTEMATIC REVISIONS

The main focal area that emanates from the Biodiversity audit is the documentation of southern African Neuroptera. The early literature on Coniopterygidae, Sisyridae, Osmylidae, Berothidae, Psychopsidae, Chrysopidae, Hemerobiidae and Nemopteridae was reviewed by TJEDER (1957, 1959, 1960, 1966, 1967), while MANSELL (1985) discussed historical literature pertaining to Myrmeleontidae from the sub-region. SMITHERS (1957, 1961) published two papers on local Sisyridae. TJEDER (1968, 1987, 1989, 1992) and TJEDER & HANSSON (1992) subsequently presented additional information on Ascalaphidae, Rhachiberothidae and Coniopterygidae.

Recent studies by ASPÖCK and ASPÖCK (1983, 1988*a,b*, 1990, 1996, 1997) (Berothidae, Rhachiberothidae), ASPÖCK and MANSELL (1994) (Rhachiberothidae), ASPÖCK and NEMESCHKAL (1998), HÖLZEL (1987, 1989, 1990*a,b*, 1991, 1992, 1993), HÖLZEL and OHM (2002) and HÖLZEL *et al.* (1997) (Chrysopidae), MANSELL (1976, 1977, 1980, 1981*a,b*, 1985, 1987, 1988, 1990, 1992, 1996) (Nemopteridae, Myrmeleontidae), MANSELL and ASPÖCK (1990) and MANSELL (2000) (species lists), MEINANDER (1972, 1975, 1983, 1998) and MONSERRAT (1998) (Coniopterygidae), MINTER (1986) (Dilaridae), OSWALD (1993, 1994) (Psychopsidae) and PICKER (1984, 1987) (Nemopteridae) have contributed significantly to documenting the taxonomy and distribution of southern African lacewings.

Studies on Chrysopidae, Hemerobiidae, Coniopterygidae, Berothidae, Rhachiberothidae, Myrmeleontidae, Ascalaphidae and Nemopteridae are ongoing, and have been elaborated by ASPÖCK (2002). A catalogue of South African Neuroptera is available on a web site (http://www.ru.ac.za/zoology/martin/insects.html), and this is to be expanded to include all sub-Saharan taxa.

LARVAL BIOLOGY AND ECOLOGY

The immature stages of southern African Neuroptera are poorly known. Only a few publications have included information on larval morphology and biology, and only the Crocinae (Nemopteridae) have been comprehensively studied (MANSELL 1976, 1977, 1980, 1981*a,b*, CROSS & MANSELL 1978). One paper (MANSELL 1973) described a larva of Nemopterinae (Nemopteridae), while three include information on Myrmeleontidae (MANSELL 1987, 1988, 1999). HENRY (1979) provided a detailed description of an unidentified larva of Ascalaphidae from KwaZulu/Natal, and Chrysopidae have been detailed in two papers (BARNES 1975, HÖLZEL *et al.* 1997). A description of the morphology and biology of an unidentified mantispid (Mantispidae) was provided by BISSETT and MORAN (1967), while MINTER (1990) presented details of the early stages of a species each of Berothidae, Rhachiberothidae and Mantispidae. The larvae of southern African Coniopterygidae, Sisyridae, Osmylidae, Hemerobiidae, and Psychopsidae have not yet been described, while very few larvae of the families Chrysopidae, Berothidae, Rhachiberothidae, Mantispidae, Nemopteridae and Ascalaphidae have been found. Extensive studies are being carried out on larvae of Myrmeleontidae by the author, and approximately 40 species have been discovered and reared.

The larval stage of Neuroptera is of the longest duration in the life cycle, it is the main feeding stage and requirements are entirely different from those of the adult. A separate suite of parameters impact upon the evolution of larvae, and on the survival and distribution of species. It is consequently essential to investigate the larvae and their environmental requirements when considering the status and conservation of species.

Larvae of lacewings are also frequently applied in biological control programmes (STELZL & DEVETAK 1999) and southern African species have considerable potential in this regard, especially the Chrysopidae and Coniopterygidae, and Myrmeleontidae for the control of ants in orchards.

Research on larvae is clearly a focal area that holds exciting potential for investigation and application, and is regarded as a high priority.

DISTRIBUTION PATTERNS AND PREDICTIVE MODELLING

The geo-referenced locality data that are recorded in the database during the biodiversity audit are used to compile distribution patterns for species. This forms the basis of several applications that are fundamental to biodiversity studies and conservation strategies. This aspect of the lacewing Monitoring Programme is car-

ried out in collaboration with the Conservation Planning Unit of the Department of Zoology and Entomology at the University of Pretoria. It is also a component of the SA ISIS2000 programme that is funded by the National Department of Arts, Culture, Science and Technology, through the Conservation Unit, headed by A. S. VAN JAARSVELD.

The lacewing data are implemented in Geographical Information Systems (GIS) modelling procedures that are applied to address several issues. These include predictive modelling for climate change scenarios (ERASMUS *et al.* 2000), identification of areas of species richness, endemicity and in reserve selection based on objective parameters (FREITAG & MANSELL 1997). This is of fundamental value to long-term ecological and conservation planning, and in sustainable development, and is of particular relevance to land-use planners and in environmental impact assessments. These products again emphasise the value of long-term taxonomic research and collaboration on southern African lacewings.

CONSERVATION STATUS AND PROTECTIVE MEASURES

The ultimate goal of accumulating specimens, associated data and the integration and analysis of the information, is to monitor the status of lacewings to ensure the conservation and survival of this rich and unique southern African heritage. The information obtained is used to model current protective measures, such as species that are protected within reserves (FREITAG & MANSELL 1997), and to identify areas that harbour vulnerable species, especially endemics, or areas that are particularly rich and in need of protection.

Many southern African species are rare, critically endangered or possibly extinct, but their status must be established and protective measures implemented should populations be discovered. Critically endangered species include: *Pamexis bifasciatus* (OLIVIER), *P. contamminatus* (HAGEN), *Exaetoleon obtabilis* (PÉRINGUEY) (Myrmeleontidae), *Sicyoptera dilatata* (KLUG), *S. cuspidata* TJEDER, *Halterina pulchella* (PÉRINGUEY) and *H. purcelli* (PÉRINGUEY) (Nemopteridae). All of these species are in the southwestern regions of the Western Cape Province, where habitat destruction is extensive. Single populations of *P. contamminatus, S. dilatata* and *S. cuspidata* have recently been discovered by R. D. STEPHEN, J. B. BALL and M. W. MANSELL, and the status of these will be monitored by revisiting the sites and informing land owners of their vulnerable presence.

CONCLUSIONS

Information emanating from this programme will contribute to knowledge of the biodiversity and ultimate conservation of the rich, but vulnerable fauna of Neuroptera of southern Africa. It is also intended to produce marketable products in the form of comprehensive data-sets and tools (databases and GIS models) that can be applied in further research, objective decision making and land-use planning. These demand-driven applications emphasise the relevance of biological collections and taxonomic research, and ensure the viability of such endeavours. It also highlights the value of collaborative and co-ordinated research, where limited resources and effort are focussed towards specific goals.

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The oribatid species described by Berlese (Acari)

by MAHUNKA, S. and L. MAHUNKA-PAPP

The authors had the opportunity for years to study the Oribatid species described by Berlese currently deposited in the Istituto Sperimentale per la Zoologia Agraria at Florence. The results of this series of studies are summarized in this volume.

The volume begins with an essay-like Introduction heavily relying on subjective opinions discussing the general questions of Oribatology. The following section lists Berlese's species placed in the modern system helping the specialists with morphological notes and many drawings; here also the condition of the specimens is discussed and lectotypes are designated.

The third, large section is the catalogue proper, wherein all the species are listed in the systematic order together with their combination and synonymic names. Here one may find all the literature data, usually missing from ordinary works, with reference to Description and Taxonomy, Distribution, with special emphasis on Catalogues whose references are partly unreliable. Where it was deemed necessary further information are added under the heading of Remarks. The volume closes with a very detailed list of literature.

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SOUTHERN AFRICAN BIOMES AND THE EVOLUTION OF PALPARINI (INSECTA: NEUROPTERA: MYRMELEONTIDAE)

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Southern Africa harbours 42 of the 88 known species of Palparini (Insecta: Neuroptera: Myrmeleontidae). Twenty-nine of the 42 species are endemic to the western parts of the subregion, including Namibia, Botswana, the Western, Northern and Eastern Cape, and North-West Provinces of South Africa. Geographical Information Systems analyses and climate change models have been used to reveal possible reasons for the high diversity and levels of endemism of Palparini in southern Africa. The analyses have indicated that climate, and the consequent rich variety of vegetation and soil types, have been the driving forces behind southern Africa being a major evolutionary centre for palparines and other Neuroptera.

Key words: Neuroptera, Myrmeleontidae, Palparini, southern Africa, biomes, Geographical Information Systems

INTRODUCTION

The varied biomes of southern Africa have engendered a proliferation of lacewings (Insecta: Neuroptera). The subregion is a major evolutionary centre for Neuroptera, with many taxa being endemic to the countries south of the Cunene and Zambezi rivers. Twelve of the world's 17 families of lacewings are represented in South Africa, which has exceptionally rich faunas of the xerophilous Myrmeleontidae (antlions) and Nemopteridae (thread- and ribbon-winged lacewings). More than half of the world's known species of Nemopteridae occur in the Western and Northern Cape Provinces of South Africa, while the great antlion tribe Palparini attains its highest level of diversity in the subregion, with 42 species being present (Table 1). This represents 48% of the total number (88) of valid species in the tribe.

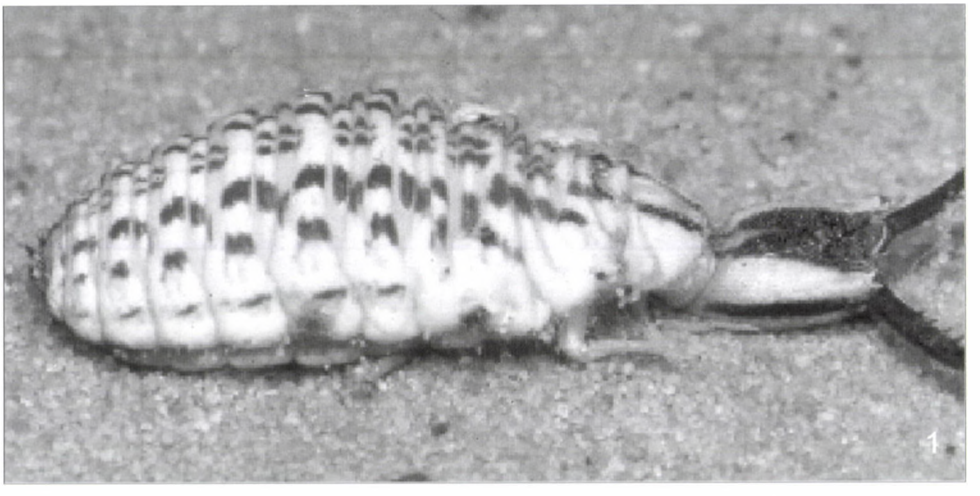
This rich variety, and the potentially detrimental effects of climate change on the fauna of southern Africa, is currently being investigated by Geographical Information Systems (GIS) analysis. In the process of modelling the known and potential distributions of Palparini in South Africa, it became evident that parameters other than climate also determined the distribution of species on the subcontinent. One of these is the influence of plant morphology on the morphology of adult

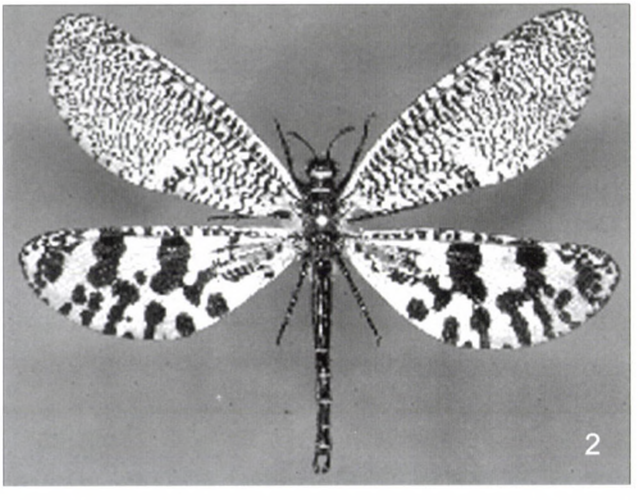
Palparini. This antlion tribe includes the largest species in the family and, consequently, the largest larvae (Fig. 1). A large larva enables these specialist predators to exploit a wide range of prey, but it also jeopardises the safety of the conspicuously large adults. Their great size renders them vulnerable to predators, and palparines have consequently evolved elaborately patterned wings to enhance their

Table 1. The Palparini of southern Africa, indicating their affiliation to the western or eastern faunal components of the subregion

Western species	Eastern species
1. *Crambomorphus sinuatus* (OLIVIER, 1811)	1. *Lachlathetes moestus* (HAGEN, 1853)
2. *C.* sp. n. 1 (Kalahari)	2. *Palpares caffer* (BURMEISTER, 1839)
3. *C.* sp. n. 2 (Namibia)	3. *P. cataractae* PÉRINGUEY, 1910
4. *Golafrus oneili* (PÉRINGUEY, 1911)	4. *P. inclemens* (WALKER, 1853)
5. *Palpares annulatus* STITZ, 1912	5. *P. kalahariensis* STITZ, 1912
6. *P. campanai* NAVÁS, 1915	6. *P. lentus* NAVÁS, 1912
7. *P. elegantulus* PÉRINGUEY, 1910	7. *P. sobrinus* PÉRINGUEY, 1911
8. *P. gratiosus* NAVÁS, 1929	8. *P. sparsus* MCLACHLAN, 1867
9. *P. immensus* MCLACHLAN, 1867	9. *P. torridus* NAVÁS, 1912
10. *P. karrooanus* PÉRINGUEY, 1910	10. *P. tristis* HAGEN, 1853
11. *P. speciosus* (LINNAEUS, 1758)	11. *Palparellus nyassanus* (NAVÁS, 1911)
12. *P.* sp. n. 1 (Gobabeb)	12. *P. festivus* (GERSTAECKER, 1894)
13. *P.* sp. n. 2 (Pofadder)	13. *Tomatares citrinus* (HAGEN, 1853)
14. *P.* sp. n. 3 (Elefantenberg)	
15. *Palparellus damarensis* (MCLACHLAN, 1867)	
16. *P. dubiosus* (PÉRINGUEY, 1910)	
17. *P. flavofasciatus* (MCLACHLAN, 1867)	
18. *P. ovampoanus* (PÉRINGUEY, 1910)	
19. *P. pulchellus* (ESBEN-PETERSEN, 1922)	
20. *P. ulrike* MANSELL, 1996	
21. *Pamares damarus* MANSELL, 1990	
22. *P. deru* MANSELL, 1990	
23. *P. nephele* MANSELL, 1990	
24. *P. parvus* MANSELL, 1990	
25. *Pamexis bifasciatus* (OLIVIER, 1811)	
26. *P. contamminatus* (HAGEN, 1887)	
27. *P. karoo* MANSELL, 1992	
28. *P. luteus* (THUNBERG, 1784)	
29. *P. namaqua* MANSELL, 1992	

camouflage. In many species these patterns mimic the dominant plant species within the biomes in which the antlions occur. This in turn restricts Palparini to the biomes that influenced their evolutionary adaptations. Each palparine species in southern Africa has a closely related sister-species that occurs in a different biome, and they are seldom sympatric. Examples of these species complexes and their morphological adaptations are discussed here to support the camouflage hypothesis, and to explain the high diversity of Palparini in southern Africa.







Figs 1–3. 1 = Larva of *Golafrus oneili* (PÉRINGUEY), length 35 mm; 2 = *Pamexis luteus* (THUNBERG), wing length 30 mm; 3 = *P. karoo* MANSELL, length 32 mm. (Photographs – 1: A. S. SCHOEMAN; others: M. W. MANSELL)

MATERIAL AND METHODS

The geo-referenced locality data upon which the GIS analyses are based, were drawn from the "Palpares Relational Database" (MANSELL & KENYON 2002). This database includes locality data from specimens in the South African National Collection, Pretoria (SANC) and other collections world-wide. The analyses were carried out by means of a model that provides a spatially explicit set of probabilities of occurrence values for each species (ERASMUS *et al.* 2000). This model was used to derive predicted distributions of antlion species based on validated records, and to generate climate-effected distribution patterns for these species under a possible climate change scenario of increasing temperatures. Recorded distributions were plotted to quarter degree grid cells (approx. 25×25 km), to which the model interpolated potential records based on climate data. These data were the mean minimum temperature of the coldest month and the mean maximum temperature of the warmest month for each grid cell, as well as the mean annual rainfall and precipitation seasonality. The latter is a joint measure reflecting when precipitation occurs, as well as the amount recorded (ERASMUS *et al.* 2000).

In addition to the climate modelling procedure, recorded distributions were also superimposed on a map of the biomes of South Africa to determine whether biotic as well as climatic factors influenced the distribution of Palparini. Data derived from such models are ultimately used to highlight areas of endemicity, species richness and to identify rare and endangered taxa with a view to providing objective criteria for selection of conservation areas and land-use planning.

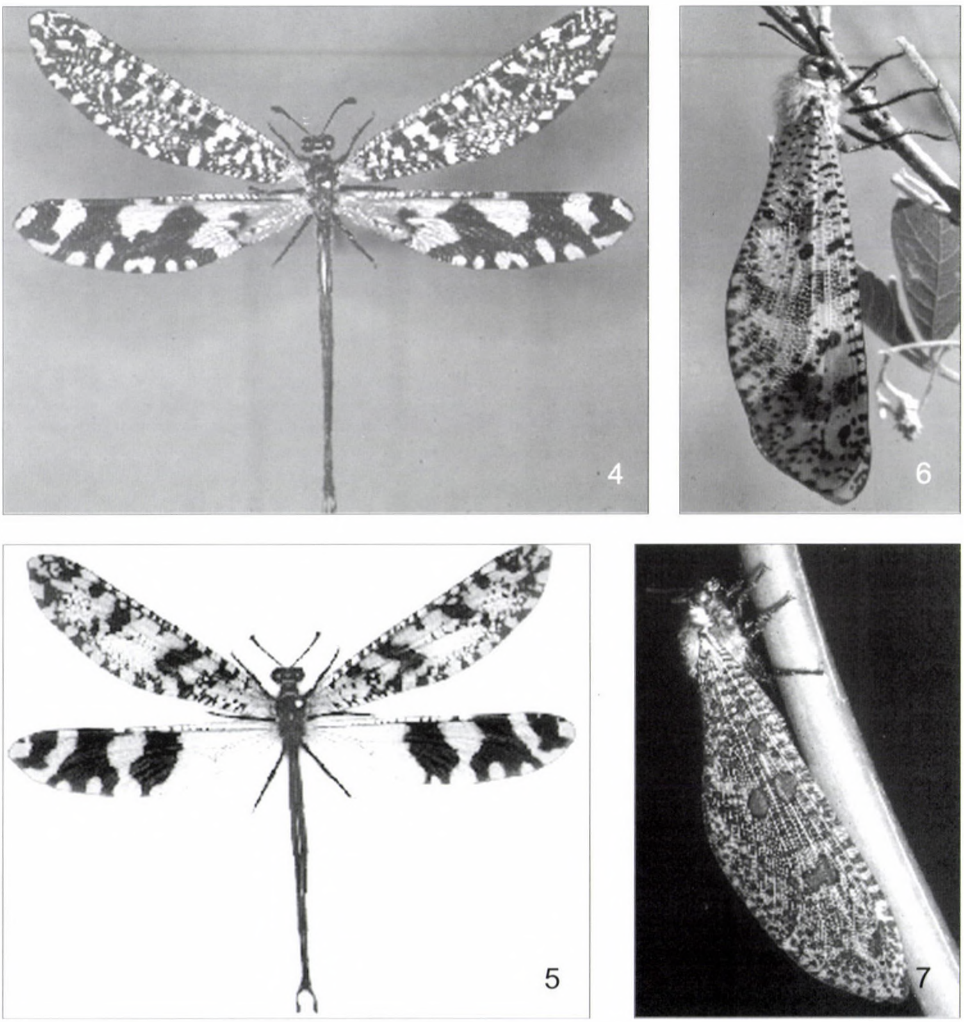
Three species-pairs were selected for comparison: *Pamexis luteus* (THUNBERG) and *Pamexis karoo* MANSELL, *Palparellus pulchellus* (ESBEN-PETERSEN) and *Palparellus ulrike* MANSELL, and *Palpares caffer* (BURMEISTER) and *Palpares speciosus* (LINNAEUS). They were identified as their distributions are well known, and because each species is restricted to a specific biome.

RESULTS AND DISCUSSION

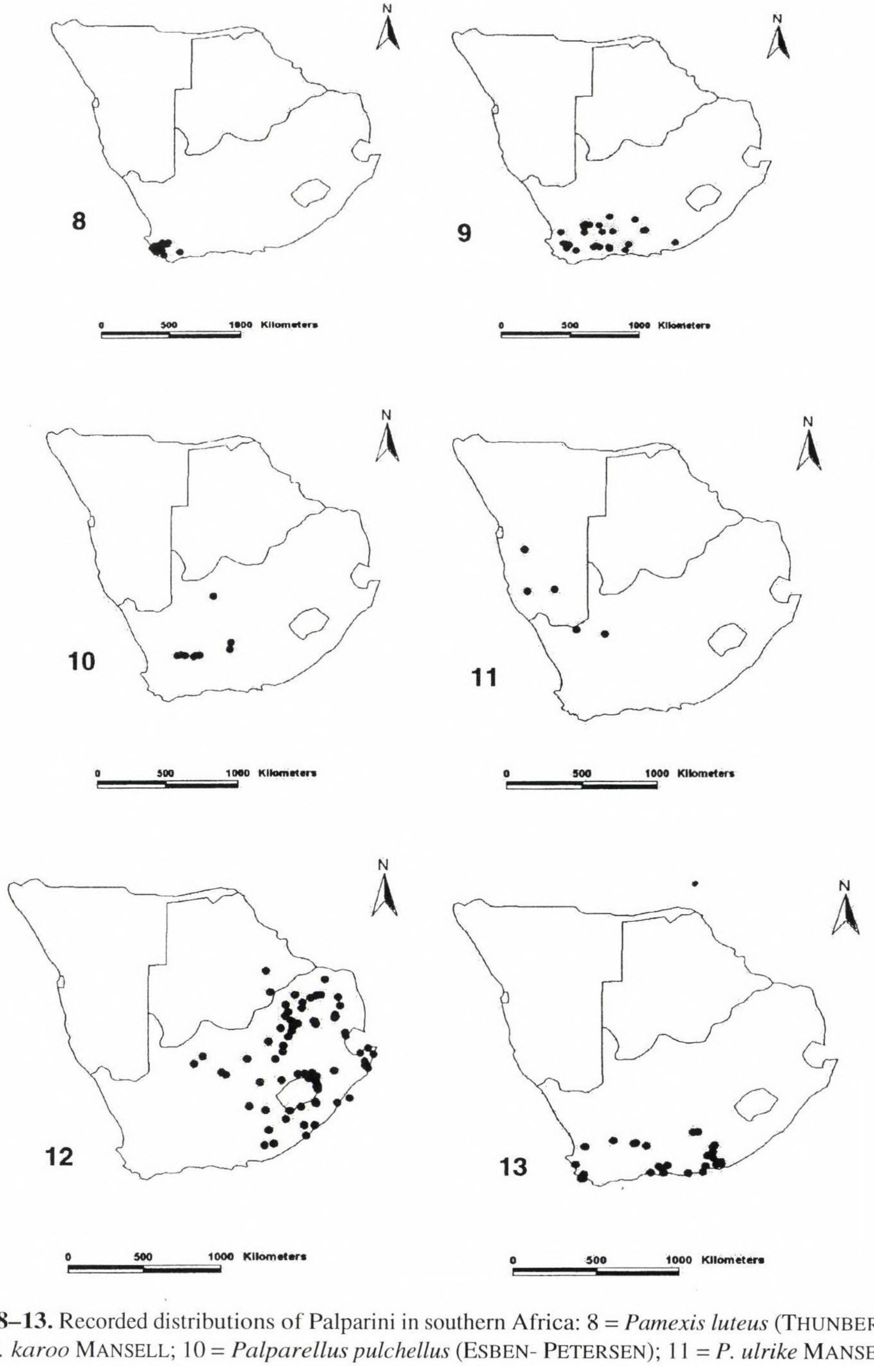
Pamexis luteus (Figs 2, 8) – This species is limited to the Fynbos biome (see REBELO 1996) in the south of the Western Cape Province. In living specimens the forewings are yellowish-green (fading to yellow in preserved material) with fine dense brown maculation.

Pamexis karoo (Figs 3, 9) – Is the sister-species of *P. luteus* and their distributions abut in the Hex River Valley area (33.29°S 19.36°E) of the Western Cape Province. *Pamexis karoo* inhabits the Nama Karoo biome (see HOFFMAN 1996), extending from Ceres (33.22°S 19.19°E) in the west to Fort Brown (33.08°S 26.38°E) in the east. It is similar to *P. luteus*, but the brown maculation in the forewings is larger and less dense than in *P. luteus*. Both *P. luteus* and *P. karoo* are diurnal and are not attracted to light. When flushed, they fly rapidly and use wind currents as an evasion strategy. The short broad wings are an adaptation to rapid and erratic flight in these day-flying species. When inactive they rest in vegetation where the patterns on the closed wings provide camouflage in the dappled shade afforded by the small-leafed fynbos or karoo (*Pentzia* sp.) vegetation.

Palparellus pulchellus (Figs 4, 10) – This species is endemic to the Upper and Great Nama Karoo biomes (see HOFFMAN 1996) and is sympatric with *Pamexis karoo* for much of its range. The wing coloration and patterns are similar in the two species, and they frequently occur in the same habitat in association with *Pentzia* bushes.



Figs 4–7. 4 = *Palparellus pulchellus* (ESBEN-PETERSEN), wing length 52 mm; 5 = *P. ulrike* MANSELL, wing length 55 mm; 6 = *Palpares caffer* (BURMEISTER), length 65 mm; 7 = *P. speciosus* (LINNAEUS), length 66 mm. (Photographs – 6: M. J. SAMWAYS; others: M. W. MANSELL)



Figs 8–13. Recorded distributions of Palparini in southern Africa: 8 = *Pamexis luteus* (THUNBERG); 9 = *P. karoo* MANSELL; 10 = *Palparellus pulchellus* (ESBEN- PETERSEN); 11 = *P. ulrike* MANSELL; 12 = *Palpares caffer* (BURMEISTER); 13 = *P. speciosus* (LINNAEUS)

Palparellus ulrike (Figs 5, 11) – This species is similar to *Palparellus pulchellus* (see MANSELL 1996), and the two are clearly sister species. The forewings of *Palparellus ulrike* are, however more sparsely marked than those of *P. pulchellus*. It occurs in the Bushman Nama Karoo biome (HOFFMAN 1996) and northwards into Namibia. Both *P. pulchellus* and *P. ulrike* are attracted to light and rest concealed amongst vegetation during the day.

Palpares caffer (Figs 6, 12) – This species is widespread in the eastern parts of southern Africa, and is essentially a species of the Grassland biome (see LUBKE *et al.* 1996), although it also occurs in grassland of the Savanna biome. *P. caffer* has sparsely marked forewings and is nocturnal, resting in long grass during the day. This is the only palparine that inhabits the high altitude grasslands of southern Africa.

Palpares speciosus (Figs 7, 13) – Was the first palparine to be described from Africa, and it replaces *P. caffer* in the Fynbos and Nama Karoo biomes (see REBELO 1996, HOFFMAN 1996), from approximately Grahamstown (33.18°S 26.32°E) westwards. As in the *Pamexis* species and *Palparellus pulchellus* the forewings are maculate, an adaptation to the dappled shade provided by the fine-leafed plants of the Fynbos and Nama Karoo biomes.

Distribution of Myrmeleontidae

The climate of southern Africa is characterised by increasing aridity from east to west on the subcontinent (Fig. 14), and this has a profound influence on the distribution of Neuroptera and other insects in the subregion. Southern African Myrmeleontidae manifest three main distributional trends (MANSELL 1990). There is an eastern faunal component, a western fauna, and a third component comprising a limited number of widespread species. The eastern component is dominated by species that are widespread in Africa, while there is a rich xerophilous element that inhabits the drier western parts of the subregion, where the annual rainfall is generally less than 500 millimetres per annum. This western fauna is characterised by a high level of endemism, and inhabits Botswana, Namibia and the Western Cape, Northern Cape, Eastern Cape, and North-West Provinces of South Africa. Of the 42 species of Palparini in southern Africa, 29 occur in the west, while only 13 inhabit the eastern side of the subcontinent (Table 1), and all but four of the western species are endemic to the subregion. *Palparellus flavofasciatus* (MCLACHLAN), *P. ovampoanus* (PÉRINGUEY), *P. damarensis* (MCLACHLAN) and *Palpares immensus* MCLACHLAN, also extend into southern Angola.

During GIS analyses a model was developed (ERASMUS *et al.* 2000) to indicate potential areas of distribution based on the climatic conditions in which the

various species were know to occur. This revealed several areas where the climate was suitable for colonisation by a particular species, but in which that species did not occur. It consequently became apparent that, although climate was important, it was not the only parameter that determined species distribution. When the recorded distributions of endemic species were superimposed on a map of the biomes of South Africa (LOW & REBELO 1996) it became apparent that most species were associated with specific areas and vegetation types. This trend is clearly manifest in the six species considered here. The general similarity in wing patterns of four species, *Pamexis luteus, P. karoo, Palparellus pulchellus* and *Palpares speciosus*, also show a striking convergence in adapting to life in the Fynbos and Nama Karoo biomes.

The increasing aridity in the west of the subregion results in the availability of large tracts of sand and exposed soil that are conducive to the large sand-dwelling larvae of Palparini. The western regions of southern Africa also include widely dif-

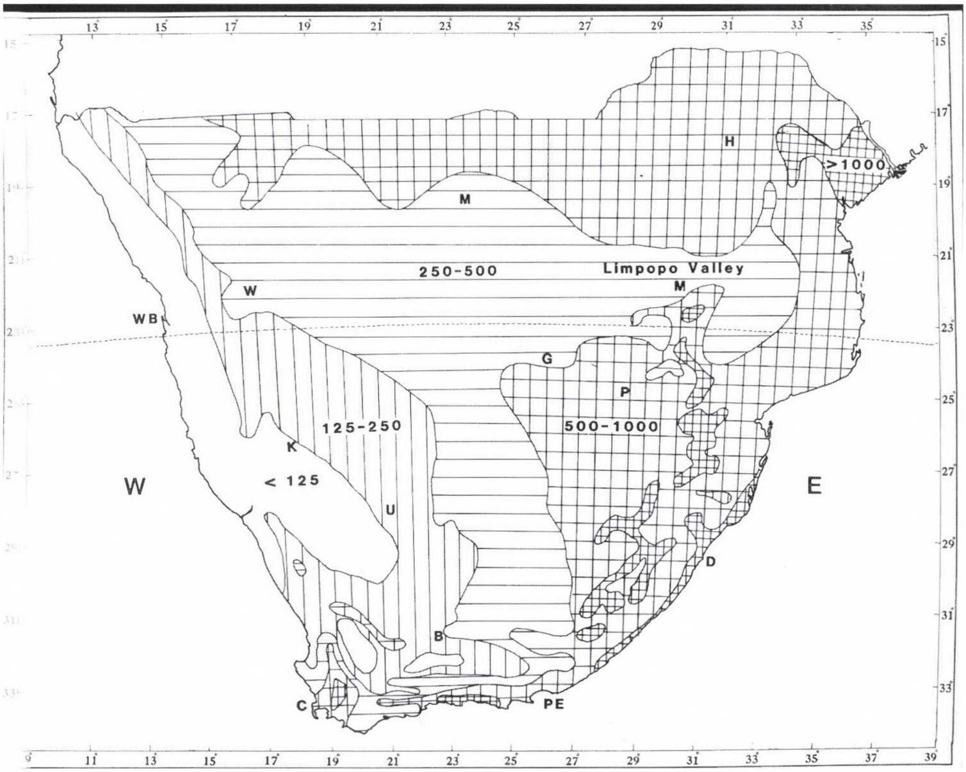


Fig. 14. Southern Africa with average rainfall pattern in mm. Abbreviations: B = Beaufort West, C = Cape Town, D = Durban, G = Gaborone; H = Harare, K = Keetmanshoop, MA = Maun, M = Messina, PE = Port Elizabeth, P = Pretoria, U = Upington, WB = Walvis Bay, W = Windhoek

fering biomes, including Desert, Nama Karoo, Succulent Karoo, Savanna and Fynbos (LOW & REBELLO 1996). The combination of these physical and biotic features, together with their associated topography and related floras, has provided numerous niches in which Palparini could evolve.

Southern Africa is also dominated by "open" biomes including Savanna, Grassland, Nama and Succulent Karoo and Desert, where trees and shrubs are either absent, sparse or low-growing. Only a very small part of South Africa is covered by Forest or Thicket biomes, which are not favoured by Myrmeleontidae, and Palparini in particular. There are consequently vast areas of southern Africa that are conducive to habitation by Palparini.

CONCLUSIONS

Southern Africa has a rich fauna of Neuroptera, with high levels of endemism. It is also the area with the world's greatest numbers of Palparini (Myrmeleontidae) and Nemopteridae. Reasons for this richness are continually being sought, especially with regard to identifying objective criteria for conservation measures and reserve selection. Modern computer technology and advanced software programmes have placed powerful database and analytical tools in the hands of biologists. These enable scientists to gather, collate and analyse data, and to apply the products in sustainable environmental planning and innovative research.

The comprehensive data set generated by the Southern African Lacewing Monitoring Programme (MANSELL 2002) has been especially valuable in contributing to the development of analytical procedures and the database model (FREITAG & MANSELL 1997, ERASMUS *et al.* 2000, MANSELL & KENYON 2002). These procedures also hold inherent heuristic value, as they frequently reveal reasons for phenomena other than those they are modelled to analyse. In the present study, climate alone could not account for the distributions of Palparini, which led to the notion that vegetation and soil types could also be a major influence. The striking congruence between recognised plant biomes and palparine distributions strongly support this hypothesis.

In the case of Nemopteridae, whose adults are specialised pollinators, such an association is obvious, but in Palparini where both larvae and adults are predacious the explanation was not as clear. The present contribution highlights another aspect of insect/plant relationships, camouflage, which is quite independent of the usual pollination or host dependence. It emphasises the close evolutionary association between insects and plants in the western regions of southern Africa, and the need for a holistic approach to ecosystem study and conservation.

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THE PALPARES RELATIONAL DATABASE: AN INTEGRATED MODEL FOR LACEWING RESEARCH

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The Palpares Relational Database has been designed for the Southern African Lacewing Monitoring Programme, to address the limitations of conventional databases and filing systems. The model has also been expanded to other collections and taxa. The application was developed in Microsoft Access®, and comprises Tables, Forms, Queries and Reports that accumulate and integrate data on Specimens, Taxonomy, Localities, Literature, Institutions, Type data, and Collectors and Authors. The model provides synchronised access to comprehensive data across multiple platforms, for potential use in many applications and products. These include publications, geographical information systems analysis, faunal inventories, environmental impact assessments, compilation of catalogues, bibliographies, and data on Neuroptera as biological control agents, as well as being an invaluable resource for taxonomic research.

Key words: Relational database, specimen data, taxonomy, localities, bibliography, institutions

INTRODUCTION

Vast amounts of specimen-related data are incarcerated in biological collections throughout the world, but it is difficult to access these records and to associate specimens with other pertinent information. Collections data are fundamental to many modern applications, research programmes, decision-making processes and products, all of which accentuate the relevance of biological holdings and taxonomic research. It is consequently imperative that these data and related information be easily accessible to the scientific community for wider application.

Labels usually provide details of locality, date and collector, but seldom reflect host associations, ecology or geo-references. Neither do specimen labels provide access to literature and taxonomy or details of type specimens and depositories. Specimen data in accession registers, card files, catalogues and taxonomic papers are merely lists that do not facilitate rapid retrieval or integration across multiple information sources. These conventional systems are also limited, as they cannot accommodate large data sets or the burgeoning accrual of biological information.

The advent of computerisation and electronic storage did not resolve these constraints as mainframe computers were not generally accessible, and required expert programmers to run even the most elementary procedures. Personal computers were initially unable to provide a solution either, as they were limited by the lack of suitable software programmes. Many products were developed and marketed as database programmes, but they were incapable of integrating large sets of data from numerous databases. These constraints have now been addressed by the relational database model that is based on concepts from a branch of mathematics known as relational algebra (CODD 1970). This model is a particular way of structuring and processing a database (KROENKE 1995) to effect maximum efficiency in data storage and retrieval. Many database management systems have consequently been developed, including Microsoft Access®, that enable scientists and business people to develop applications to accumulate, collate and manipulate data in an unprecedented manner.

Microsoft Access® has been used to design and produce database applications that electronically document information in biological collections. The model described here, the PALPARES RELATIONAL DATABASE, was specifically developed to gather and integrate data on specimens of Neuropteroidea, and to combine all pertinent information relating to Afrotropical Neuroptera into one source, especially with regard to the Southern African Lacewing Monitoring Programme (MANSELL 2002). This relational database application has also been applied to other regional faunas and widely disparate taxa, and is the model used to document the holdings of the South African National Collection of Insects in Pretoria.

RATIONALE

The relational database concept is based on a two-dimensional table (KROENKE 1995). Each row holds data that pertain to some tangible entity (*e.g.* specimen, locality, reference), and is referred to as a record. No records (rows) should be duplicated and each entity requires a separate table. Columns (also referred to as fields) contain related data pertaining to attributes of the entity (*e.g.* name, collection date, locality), and each column has a unique value and name. The resultant cells formed by the rows and columns must be single-valued, and the consequent relationship between the row, column and cell ensures that each cell in a relational table contains unique information. The relational tables are structured in such a way as to reflect as much information as possible about each entity, thereby providing a record with unique values. These unique values ensure maximum efficiency of data storage, integration and retrieval, and prevent duplication.

Data are stored in the relational tables, each of which is a discrete database comprising related data. The data in a table are not repeated in other tables except for the fields that link the tables to each other to facilitate data integration and retrieval across multiple tables. Each table should have a key field that identifies the entity of that table (*e.g.* a genus and species combination defines the Species taxonomy table) and duplicates should not be permitted This facilitates efficient information retrieval and the integrity of data.

DESIGN

A relational database management system (RDBMS) provides tools for the development of applications, and the resultant model usually consists of Tables, Forms, Queries, Macros, Reports and Modules. The PALPARES RELATIONAL DATABASE application comprises the following tables: Specimen data, Species taxonomy, Genus taxonomy, Localities, Bibliography, Institutions and Persons, in

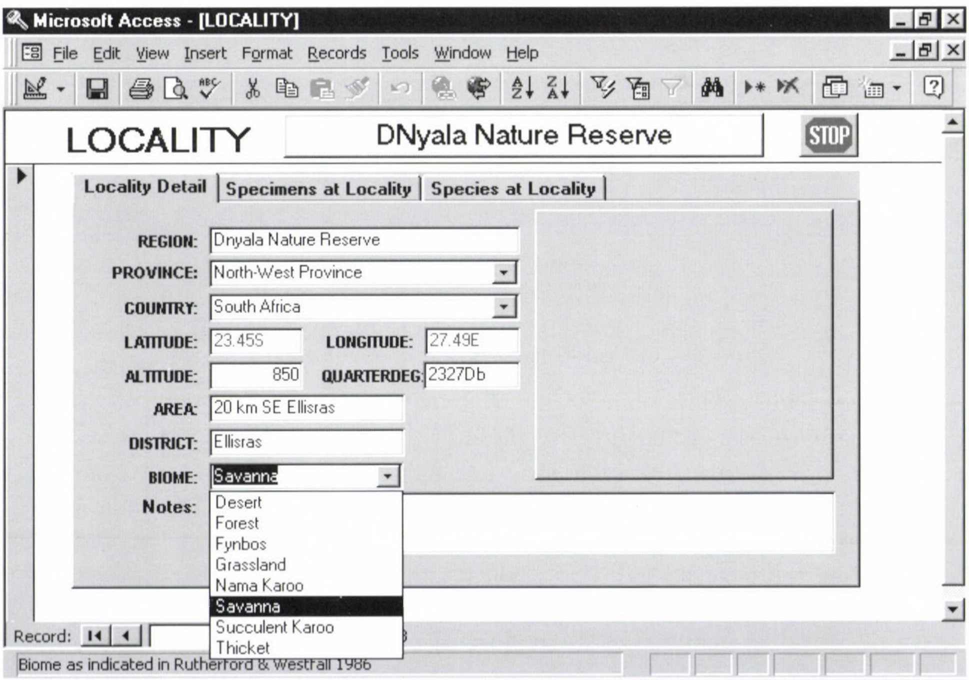


Fig. 1. The Localities form, to illustrate the use of the glide-down menu for Biomes

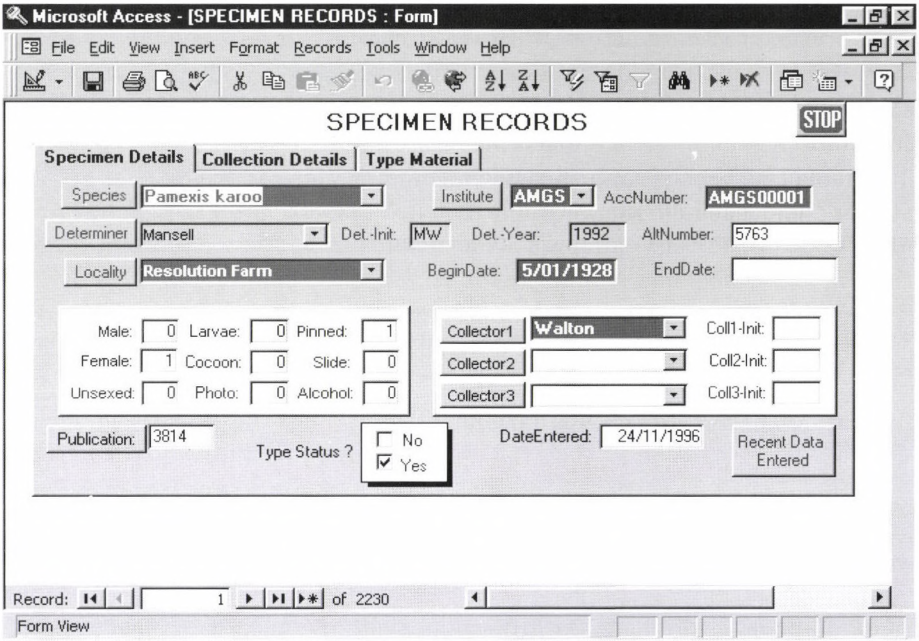


Fig. 2. The Specimen data form, to illustrate the various components of a data-entry form

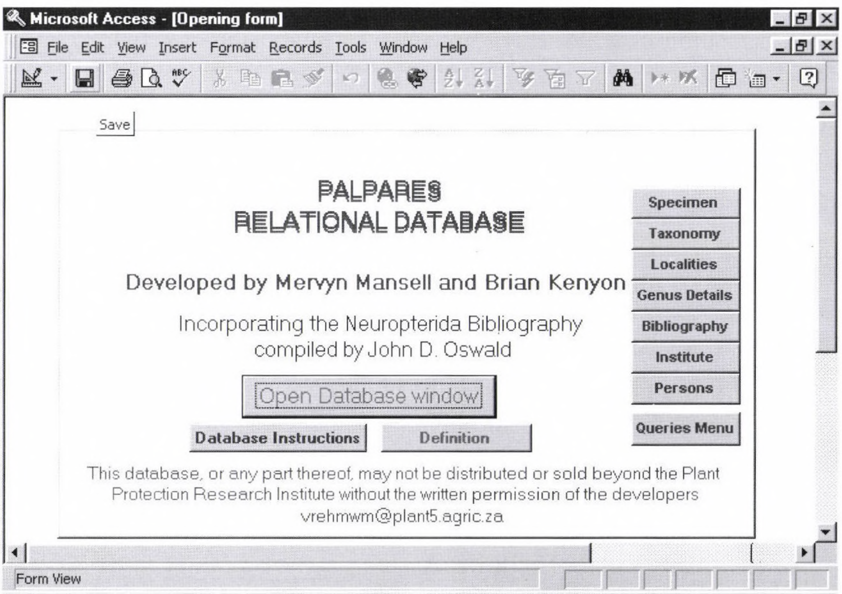


Fig. 3. Opening page of the Palpares Relational Database, to illustrate the command buttons for opening the constituent database forms

Table 1. The fields and format of the Specimen data table of the Palpares Relational Database

Field Name	Data Type	Control Type (Field)	Description
Genus & Species	Text	Combo Box	Valid genus and species, *linked to Form: Species taxonomy*
Accession Number	Text	Text Box	Key Field - Unique Accession Number
Alternate Number	Text	Text Box	*e.g.* Field number, collection code, original accession
Determiner	Text	Combo Box	Most recent determiner, *linked to Form: Persons*
Determiner Initials	Text	Text Box	Initials of determiner, automatically updated
Year of Determination	Number	Text Box	Year in which specimen/s were determined
Institute	Text	Combo Box	Name of depository, *linked to Form: Institute*
Locality	Text	Combo Box	Name of locality, *linked to Form: Locality*
Begin Date	Date/Time	Text Box	Date on which specimen/s were collected
End Date	Date/Time	Text Box	Last date, if specimen/s were collected over a time-span
Males Pinned	Number	Text Box	Number of males pinned or micro-pinned
Females Pinned	Number	Text Box	Number of females pinned or micro-pinned
Unsexed Pinned	Number	Text Box	Number of unsexed specimens pinned or micro-pinned
Total Pinned	Number	Text Box	Total specimens pinned or micro-pinned
Larvae	Number	Text Box	Number of larvae
Cocoons	Number	Text Box	Number of Cocoons
Slides	Number	Text Box	Number of slides
Alcohol Material	Number	Text Box	Number of specimens in alcohol - not recommended !
Card Points	Number	Text Box	Number of specimens on card points - not recommended !
Capsules	Number	Text Box	Number of specimens in gelatine capsules
Photographs	Number	Text Box	Photograph/s of specimen/s- can be hyperlinked
Genitalia in capsules	Y/N	Check Box	Records whether dissected genitalia are associated
Collector1	Text	Combo Box	Collector of specimen/s, *linked to Form: Persons*

Table 1 (continued)

Field Name	Data Type	Control Type (Field)	Description
Collector1 Initials	Text	Text Box	Initials of collector, automatically updated
Collector2	Text	Combo Box	Second collector of specimen/s, *linked to Form: Persons*
Collector2 Initials	Text	Text Box	Initials of second collector, automatically updated
Collector3	Text	Text Box	Third collector of specimen/s, *linked to Form: Persons*
Collector3 Initials	Text	Text Box	Initials of third collector, automatically updated
Habitat	Text	Text Box	Habitat, *linked to Lookup Table: Habitats*
Collection Method	Text	Text Box	Method of collection, *linked to Lookup Table: Methods*
Publication	Text	Number	Publication pertinent to specimen/s, *linked to Form: Bibliography*
Date Entered	Date/Time	Text Box	Date on which entry was made, automatically updated
Recent Data Entered	Query	Command Button	Command button to run query on entries since specified date
Specimen Notes	Memo	Memo Field	Additional notes pertaining to specimens
Type Status	Y/N	Check Box	Indicates whether specimen/s have type status
Primary Type	Text	Combo Box	Indicates whether specimen/s include a primary type
Sex of PT		Toggle Button	Indicates sex of primary type
Secondary Type	Text	Combo Box	Indicates whether specimen/s include secondary types
Sex of ST		Toggle Button	Indicates sex and number of Secondary type/s
Original Name of Type	Text	Combo Box	Original name of type, *linked to Form: Species taxonomy*
Type Number	Text	Text Box	Catalogue number of type
Type Notes	Memo	Memo Field	Additional notes pertaining to type specimens

which incremental data are stored, edited and cross-referenced to other tables. As an example, Table 1 provides a list of the fields currently included in the Specimen data table, with an indication of the linkages to other tables (in italics). Specimen data is the core table that is supported by information from the other tables, although each of these is a functional database that, in turn, is linked to the other tables. There are also static tables that include only one or two fields to provide details for the glide-down menus in forms (Fig. 1).

Data are entered into tables through specially designed forms that function as an interface between data input personnel and the tables. Each form includes the fields from its underlying table, and consists of an electronic page that can comprise one or more tab controls (Fig. 2). The forms, and consequently their underlying tables, are linked to other forms by command buttons and glide-down menus, making it possible to move between forms by simply clicking a button.

Queries are structured to question the data in the tables, and are programmed to retrieve and correlate data from single or multiple tables to answer specific questions. The structure of the queries is fundamental to the design of a database, and consideration should continually be given to the nature of the questions that the database would be expected to provide. Queries can also be used to facilitate the manipulation of data, and in the compilation of the database.

Reports are drawn from the data and structured into a variety of publishable formats, for example, lists of publications. Macros and modules are used in the design process, and are essentially the programming languages of the database.

The PALPARES RELATIONAL DATABASE is designed to provide a user-friendly interface that is self-describing and requires minimal computer skills to operate. This is to ensure that large amounts of data can be entered without prerequisite knowledge of a specific taxon, or a background in database modelling and philosophy. Because of the nature of relational databases, potentially repetitive information need only be entered once. It is then accessed by data input personnel through glide-down menus and controls (fields) on forms that automatically suggest words after a few keystrokes. This facility protects the integrity (correctness) of data and prevents duplication, unnecessary keystrokes and variant spelling.

PROCEDURE

The database is opened via an icon on the screen desktop of a personal computer. This accesses the opening form (Fig. 3) that provides access to all forms through a series of command buttons arranged as a switchboard. By clicking the button displaying the name of a form, the form will be opened and data input can

commence. This stage is reached by only two clicks of a mouse button, ensuring maximum efficiency.

Input usually commences by opening the Specimen data form (Fig. 2) and entering information about a specimen (or batch of identical specimens) into the relevant controls (fields). If data (*e.g.* species names, localities) are already available in the other forms (Species taxonomy, Localities), these details are accessed and entered through the glide-down menus activated by clicking the down arrow on the control. Details of that entry can then also be viewed and edited by clicking the command button associated with that specific control. This opens the relevant form. For example: the genus and species can be entered into a blank field by typing the first few letters of the name. If the name is already in the Species taxonomy table, it will be automatically entered from that linked source. Alternatively, the down arrow on the control can be clicked to activate the glide-down list of species names, and the relevant name can be entered by highlighting it and double-clicking a mouse button. The name is then inserted in its correct form. All taxonomic details of that species can be viewed and edited by clicking the command button that opens the form.

Table 1 provides a list of fields in the Specimen data table, together with data and field types, and an indication of which fields are linked to a common field in another form. The linkage is activated through a combo box (combining data from another table) or a command button. Each of the other tables is similarly structured with a key field that links it in a one-to-many relationship with the other tables.

The forms can also include sub-forms that are placed under the tab controls to provide additional related information. The sub-forms are usually based on a query that is activated by clicking on the tab of the tab control. For example: the Localities database includes sub-forms that, when activated, provide a list of all species and specimens recorded from a specific locality. This is based on a query that filters all records of specimens in the Specimen data table from that locality.

The Bibliography table (and form) includes the Neuropterida database compiled by OSWALD (1998), and currently comprises 9143 literature records that are linked, through a unique number, to other forms.

Similarly, data in other tables and forms are derived from currently available sources. Data in the Localities table is derived from existing gazetteers such as the National Imagery and Mapping Agency (NIMA) database (www.nima.mil), 1:250 topographical maps, regional gazetteers, atlases and geographical positioning systems (GPS). Information in the Species and Genera taxonomy tables is derived from published taxonomic literature.

Additional features include command buttons on forms that run queries associated with that form. For example, a command button on the Persons form runs a

query that will list the publications by specified authors that are in the Bibliography. Likewise, it is possible to view all recent entries in a table by activating a query through a command button and entering a start date.

Each field in a table and, consequently a form, is self-describing in that the domain (description of format) of the field's attributes is specified when compiling the table. Furthermore, each field is labelled, and includes a control tip – a line of text that indicates how data should be entered. This feature is activated when the mouse pointer is used to indicate a particular control.

In compiling a database, it is important for a specialist to provide the taxonomy, localities, institutions and persons data, to ensure its accuracy and prevent errors by inexperienced data input personnel.

ADVANTAGES OF THE RELATIONAL DATABASE MODEL

The PALPARES RELATIONAL DATABASE and similar models provide numerous advantages over conventional systems, including:

- The application ensures complete integration of data and simultaneous access to multiple sets of data.
- It provides flexibility, in that the design can be modified and expanded at any time without recourse to database programmers.
- The database co-ordinator has complete control over the system at all times.
- Microsoft Access® is the state-of-the-art relational database management system, and any future developments will have to accommodate applications derived from it. Data will consequently not become inaccessible in an obsolete system.
- The development software will accommodate upgrades.
- Time consuming entry of duplicate data is eliminated. Potentially repetitive information is only entered once, and many records can be updated (*e.g.* in the event of name changes or errors) by modifying a single entry.
- Data are logically consistent as a result of the referential integrity facility.
- The model can operate on personal computers as well as in multi-user network environments.

FUNCTIONS OF THE PALPARES RELATIONAL DATABASE APPLICATION

Although this application had been specifically developed for Neuropteroidea, it can be adapted to any group of biological organisms. It is designed to accomplish, among others, the following functions:

- Accumulation, electronic storage and integration of all information pertaining to Neuropteroidea;
- Compilation of electronic archives of specimen data to provide a virtual duplicate resource as insurance against loss of specimens or destruction of the collection;
- Rapid access to specimen data via internet and other electronic pathways;
- Cross-referencing the specimen data to information on taxonomy, type specimens and depositories, literature, localities, distribution, phenology, collectors, authors and economic applications;
- Design of queries based on the above data-sets provide rapid retrieval of information (*e.g.* specimens and species per locality, depository or collector; compilation of faunal lists, bibliographies, type depositories; updating data-sets with external data by append queries; modification of data-sets with update queries).
- Incorporation of graphics affords illustrations of specimens, type specimens, localities, persons and museums;
- Instant access to information in linked objects through command buttons, glide-down menus, tab controls and sub-forms;
- Large amounts of related data are immediately accessible through these facilities.

CONCLUSIONS

Modern computer and software technology have placed powerful archiving and analytical tools in the hands of biologists. Biological data can now be accrued, co-ordinated, disseminated and applied as never before. Electronic relational database management systems have provided a vehicle for the development of increasingly significant products, that emphasise the infinite value and relevance of biological collections and taxonomic research. For the first time in over 250 years of taxonomic research biologists are able to gather and collate data from over two centuries, and from multiple sources, into single access and retrieval applications.

Instead of lying fallow in countless collections and outmoded filing systems because of their inaccessibility, biological data now have the potential to become a living resource. This will, however, require a revision of established mind-sets where, even now, such data are zealously guarded. In future, any collections whose data are not electronically accessible, and shared, will rapidly become irrelevant. Unprocessed specimen data in collections is not intellectual property, but only become such once value has been added to them through their inclusion in scientific applications, and in the generation of demand-driven products.

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NEW RECORDS OF NEUROPTERA FROM IRAN

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Seven provinces of Iran were surveyed for Neuroptera. Three species are newly listed for the fauna of Iran.

Key words: Neuroptera, Iran

INTRODUCTION

A list of 39 species of Neuroptera from various parts of Iran were identified and published by MIRMOAYEDI (1998) and later supplemented by a further 16 species (MIRMOAYEDI *et al.* 1999). The list presented here contains 23 species of Neuroptera of Iran of which 3 species are new for the fauna of Iran: one species of Chrysopidae, and two species of Coniopterygidae. The total estimated number of species of Neuroptera in Iran is 168.

MATERIALS AND METHODS

Seven different provinces of Iran (Fars, Golestan, Hamadan, Hormozgan, Kermanshah, Khorassan and Kurdistan) were surveyed and Neuropteran species belonging to 7 different families were captured from 19 locations, in hand net and the light trap samples. Most of the specimens were captured with a 200 watts tungsten light trap. Specimens were preserved dry, except Coniopterygidae which were preserved in 70% ethanol. Genitalia of the all male specimens were dissected, treated in 10% hot KOH, washed with 70% ethanol, studied and stored in glycerine in plastic vials. The material is housed in the Department of Plant Protection, College of Agriculture, Razi University of Kermanshah, Iran.

The following locations (indicated by arabic numerals in the map of Iran – Fig. 1) yielded Neuroptera. Abbreviations refer to provinces:

Gol – Golestan province, north of Iran. Habitats include steppe, forest and bushland. Golestan National park (GNP) is situated in this province and has an area of ninety thousand hectares. The Neuroptera fauna of GNP has been carefully described by YASSAYIE & MIRMOAYEDI (1998) and MIRMOAYEDI *et al.* (1999).

Hor – Hormozgan Province; South of Iran. The climate is hot and humid; the temperature of certain days in summers going as high as 48 centigrade.

Ham – Hamadan Province. This mountainous region has cold weather in the winter and high temperatures in the summer.

Khor – Khorassan Province. The Dasht Kavir desert covers half of this province and is saline and unarable.

Ker – Kermanshah Province. A principally mountainous western province of Iran, with a temperate mediterranean climate.

Kurd – Kurdistan Province. A principally mountainous western province of Iran with cold climate in winter, (as low as –10°C), but hot (sometimes 40°C) in summer.

Fars – Fars Province. The collecting location – Mehran Racing Club (MRC) – is situated in Shiraz, the principal town of Fars province.

1. Badelan serkan (Ham) 1850 m,
2. Bandar Lengeh (Hor) 10 m,
3. Bazangan (Khor) 1100 m,
4. Dasht (GNP) 150 m,
5. Gazir (Hor) 12 m,
6. Golzar camping (GNP) 150 m,
7. Guilangharb (Ker) 1420 m,
8. Kermanshah (Ker) 1300 m,
9. Tang Kenesht (Ker) 1300 m,
10. Shahinghaleh Mashad (Khor) 970 m,
11. Razab marivan (kur) 1320 m,
12. Minoodasht (Gol) 180 m,
13. Assadabad Neishabur (Khor) 1210 m,
14. Robat sarposh sabzevar (Khor) 960 m,
15. Sarakhs (Khor) 275 m,
16. Sharlegh (GNP) 190 m,
17. Shiraz (MRC) 1540 m,
18. Tange Gol (Gol, GNP) 170 m,
19. Tehran 1110 m,

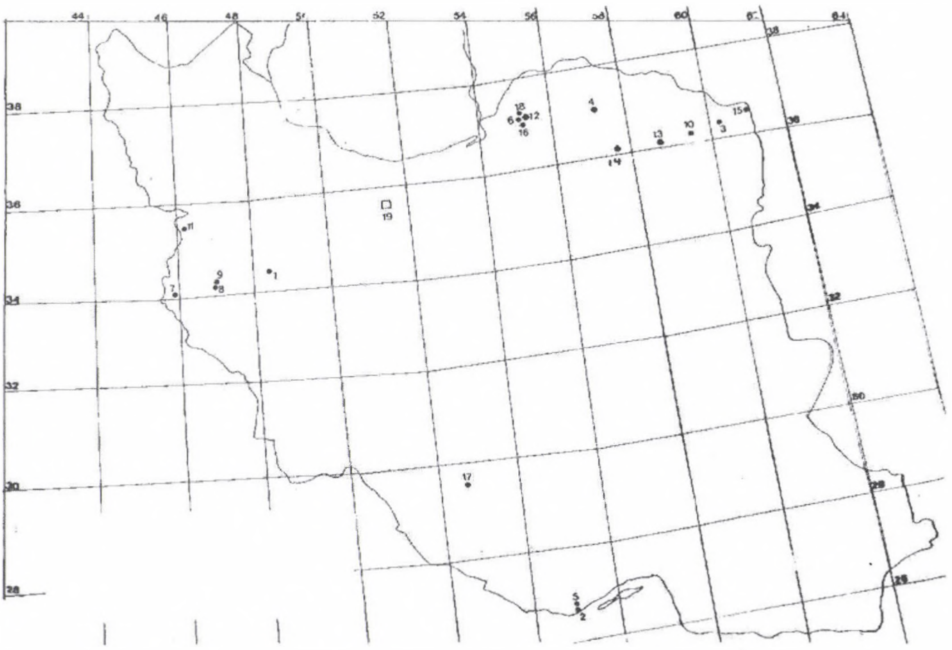


Fig. 1. Collecting sites in Iran, from which Neuroptera have been recorded

RESULTS

Twenty-three species were found among the Neuroptera captured in different regions of Iran from 1995 to 1999, including 3 Chrysopidae, 5 Coniopterygidae, 9 Myrmeleontidae, 1 Ascalaphidae, 1 Dilaridae, 2 Nemopteridae, and 2 Mantispidae. The species determined are as follows :

Chrysopidae

Anisochrysa flavifrons (BRAUER, 1851) – 1 male, Razab Marivan; 2.06.1998.

Chrysoperla sillemi (ESBEN-PETERSEN, 1935) – 1 male, Badelan Serkan, 20.08.1999; (first report for Iran).

Italochrysa vartianorum HÖLZEL, 1967 – 1 male, Razab Marivan, 3.07.1997.

The fauna of Chrysopidae of Iran was studied by HÖLZEL (1966, 1967, 1981). The total number of Chrysopidae from Iran, reported by him and other authors, is 45 species.

Coniopterygidae

Coniopteryx (*Holoconiopteryx*) *drammonti* ROUSSET, 1964 – 1 male, Dehpayien serkan, 21.08.1999; (first report for Iran).

Coniopteryx (*Xeroconiopteryx*) *furcata* MEINANDER, 1998 – 7 males, 2 females, Shahinghaleh Machad, 14.08.1999.

Coniopteryx (*Xeroconiopteryx*) *manka* ASPÖCK, H. & U, 1965 – 1 male, Shiraz, 24.07.1998; (first report for Iran).

Hemisemidalis pallida (WITHYCOMBE, 1924) – 2 males, Razab Marivan, 1.05.1998; 1 male, Gazir, 12.07.1994.

Nimboa asadeva RAUSCH & ASPÖCK, 1978 – 1 male, Razab Marivan, 1.05.1998; 1 male, Gazir, 12.07.1997.

The Coniopterygidae of Iran was studied by ASPÖCK & ASPÖCK (1965), RAUSH & ASPÖCK (1978), MEINANDER (1998), MIRMOAYEDI (1998) and the total number of species reported from Iran is 25 species.

Dilaridae

Dilar kirgisus ASPÖCK, H. & U., 1967 – 20 males,Tang Gol (GNP), 1.08.1997

Myrmeleontidae

Palpares libelluloides (LINNAEUS, 1764) – 2 females, Kermanshah, 1–13.07.2000.

Palpares solidus GERSTAECKER, 1894 – 1 male, Kermanshah, 1.07.2000.

Acanthaclisis occitanica (VILLERS, 1789) – 1 male, Almeh (GNP), 17.9.1996; 1 male, Guilan Gharb, 9.6.1996; 1 male, Islamabad gharb, 1.06.1999.

Distoleon tetragrammicus (FABRICIUS, 1798) – 1 male, Kermanshah, 1.07.2000.

Neuroleon dianae HÖLZEL, 1972, 1 female, Islamabad, 15.06.1999.

Macronemurus persicus (NAVÁS, 1915) – 5 males, 8 females, Bazangan, 60 km to Sarakhs, 15.06, 17.8.1999.

Creoleon plumbeus (OLIVIER, 1811) – 10 males, 10 females, Kermanshah, 12.08.1996, 12.06.1997; 5 km to Sarakhs, 15.06.1999; Badelan Serkan, 16.8.1999.

Creoleon griseus (KLUG in EHRENBERG, 1834) – 1 male, Kermanshah, 11.7.1999.

Delfimeus intricatus (HÖLZEL, 1972) – 1 male, Badelan Serkan, 15.8.1999.

The Myrmeleontidae of Iran was studied by HÖLZEL (1968, 1972). The total number of species from Iran, reported by him and other authors, is 80. Some other species, not included in the above list remain to be determined, for example, a lot of specimens of *Myrmecaelurus* sp.n., known from Iran (MIRMOAYEDI *et al.*, 1999) were captured from new localities.

Ascalaphidae

Bubopsis hamatus (KLUG in EHRENBERG, 1834) – 1 male, 1 female, Kermanshah, 14.08.1997

Nemopteridae

Dielocroce maxima HÖLZEL, 1975 – 1 male, Badelan Serkan, 20.8.1999.

Dielocroce vartianae HÖLZEL, 1975 – 2 males, Razab Marivan.18.6.1997.

The Nemopteridae of Iran was studied by ALEXANDROV-MARTYNOV (1930) and HÖLZEL (1975); the total number of Nemopteridae from Iran, reported by these authors, is 15 species. In the Plant Protection collection, 3 more undetermined, putatively new, species are present.

Mantispidae

Mantispa styriaca (PODA, 1761) – 1 male, Golzar camping (GNP), 27.7.1997.

Mantispa aphavexelte ASPÖCK, U. & H., 1994 – 1 male, Sharlegh (GNP), 28.7.1997.

*

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ENZYMATIC POLYMORPHISM IN CHRYSOPERLA CARNEA (STEPHENS) AND C. KOLTHOFFI (NAVÁS) (NEUROPTERA : CHRYSOPIDAE)

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Isozymes can be used in order to study the importance of reproductive barriers between populations or species. The aim of this work is to study allozyme polymorphism in natural populations of *Chrysoperla carnea* (STEPHENS) and *Chrysoperla kolthoffi* (NAVÁS) collected in the West of France. Two enzymatic systems were studied by starch gel electrophoresis: diaphorase (DIA) and isocitrate dehydrogenase (IDH). For each enzymatic system, presumed loci were scored and genetic interpretation was proposed. The study of allozyme polymorphism at the DIA and IDH-2 loci provided evidence of marked genetic differences between *Ch. carnea* and *Ch. kolthoffi*.

Key words: lacewing, *Chrysoperla carnea, C. kolthoffi*, isozymes, electrophoresis

INTRODUCTION

The common green lacewing *Chrysoperla carnea* (STEPHENS) *sensu lato* is a cosmopolitan and eurybiote chrysopid (ASPÖCK *et al.* 1980), which has long been considered as a single cosmopolitan species, although showing local biotypes differing in seasonal and life history characters (SHELDON & MACLEOD 1974, AL-ROUECHDI & CANARD 1979). This situation makes the status of this species imprecise (BROOKS 1994, ASPÖCK & HÖLZEL 1996). Recent works have shown that this presumed species correspond in reality to a "complex" of morphologically and biologically different taxa (LERAUT 1991, THIERRY *et al.* 1992, 1994, 1998, DUELLI *et al.* 1996, HENRY *et al.* 1996). At least three species are recorded in the western part of Europe: *Ch. lucasina* (LACROIX), *Ch. carnea sensu stricto* and *Ch. kolthoffi* (NAVÁS) (THIERRY *et al.* 1996).

Working on determination of genetic variations by mean of electrophoresis, BULLINI and CIANCHI (1984) and CIANCHI and BULLINI (1992) in Europe and MARTINEZ WELLS (1994) in North America found some evidence supporting the existence of this complex. THIERRY *et al.* (1997) in an electrophoretic study on EST (esterase) and ACP (acid phosphatase) showed significant divergence between *Ch. lucasina* (LACROIX) and the two other common green lacewings present

in West Europe: *Ch. carnea* s. s. and *Ch. kolthoffi* (NAVÁS). The aim of this work is to study allozyme polymorphism in natural populations of this two last species.

MATERIAL AND METHODS

Collection site and identification

Sampling was carried out during the last week of August 1999, in the mid Loire valley, near the town of Angers (France), lat. 47°28'N, long. 0°33'E. The sampling zone is an alluvial area between the Loire and one of its tributaries, the Maine. The vegetation is an Atlantic type of bocage (CORILLION 1966), the arborescent vegetation being mainly composed of elm, ash and oak. At the beginning of September we can presume that a majority of adults had entered diapause (HONEK & HODEK 1976) and offered good conditions for electrophoresis (THIERRY unpublished data).

A total number of 75 adults of chrysopids were collected by hand net in the lower canopy (< 4 m) of isolated deciduous trees. After the capture, each lacewing was identified according to the criteria and the typology proposed by THIERRY *et al.* (1998) following the nomenclature proposed by LERAUT (1991) (see voucher specimens deposited in the collection of Université Catholique de l'Ouest, IRFA, F–49000, France).

The chrysopid specimens were homogenized in Eppendorf tubes containing 100 µl of extracting buffer* per specimen. Homogenates were centrifuged at 20000 g for 10 min. The supernatant was absorbed into several pieces of Whatman chromatographic paper, used as inserts in 12% starch gels. The gels were prepared according to CARDY and BEVERSDORF (1984) using hydrolyzed starch and a histidine-citrate buffer system (pH 6.5) and electrophoresed at 4°C.

Two enzyme systems were tested by appropriate staining (ACQUAAH, 1992): diaphorase (DIA) and isocitrate dehydrogenase (IDH).

Allozyme frequencies for each sample were derived from the electrophoretic results. Hardy-Weinberg equilibrium was tested using an exact test procedure. P-value of the test was calculated by means of a simulation algorithm according to GUO and THOMPSON (1992). Analyses were performed using the software package GENEPOP (RAYMOND & ROUSSET 1995).

RESULTS

Two IDH presumed loci were detected, but only the anodical one (IDH-2) was studied, the region IDH-1 not being clearly resolved. IDH-2 was found to be polymorphic for the two forms (Fig. 1).

DIA profiles were composed by several bands (Fig. 2), but the only detected variation concerned the presence or absence of the most anodical band. When present, this band was faint in some specimens but not in others. We considered this situation as the expression of a locus with two alleles, one of them being a null one, the heterozygous genotypes being recognized by the faint band.

* tris 0.1 M, polyvinylpyrrolidone 40 (8%), adjusted at pH 7.5 with HCl

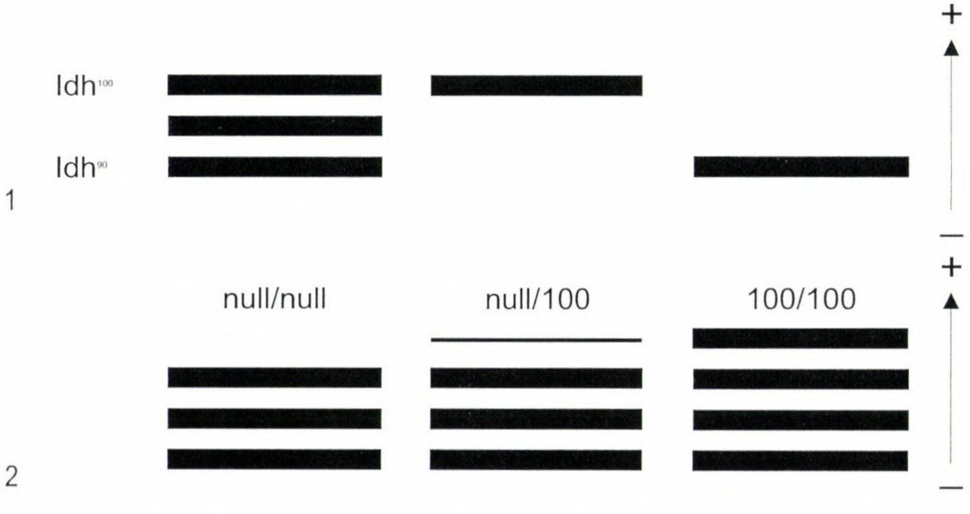
Table 1. Allele frequencies at the loci IDH-2 and DIA in *Chrisoperla carnea* (N=44) and *Ch. kolthoffi* (N = 31) and exact test for deviation from Hardy-Weinberg equilibrium

	Ch. carnea s. s.	*Ch. kolthoffi*
IDH–2^{100}	0.920	0.419
IDH–2^{90}	0.080	0.581
P-value	0.013	1
DIA^{null}	0.917	0.556
DIA^{100}	0.083	0.444
P-value	0.126	0.698

The differences in allele frequencies between the two samples were highly significant (Table 1). Both samples were in Hardy-Weinberg equilibrium for DIA but only the *Ch. kolthoffi* sample was in Hardy-Weinberg equilibrium for IDH-2.

DISCUSSION

A low heterozygous frequency for IDH-2 in *Ch. carnea* is associated with the lack of Hardy-Weinberg equilibrium and could be attributed to a certain degree of consanguinity, but the results obtained for DIA are not in accordance with this sup-



Figs 1–2. Isozyme patterns in *Chrysoperla carnea* and *Ch. kolthoffi*: 1 = isocitrate dehydrogenase, 2 = diaphorase

position. Other factors (selection, migration preceding entering in hibernation sites) could explain the lack of equilibrium for IDH-2 but we have no evidence of this. The study of allozyme polymorphism at the DIA and IDH-2 loci give evidence of marked genetic differences between *Ch. carnea* and *Ch. kolthoffi*. These results complete those obtained by THIERRY *et al.* (1997) in their study of esterases and acid-phosphatases and are in accordance with the morphological and ecophysiological differences observed between *Ch. carnea* and *Ch. kolthoffi* (THIERRY *et al.* 1994). Ecophysiological differences in life-history (TAUBER & TAUBER 1985) and pre-mating barriers like variations in courtship song patterns (HENRY 1985) might contribute to limit gene flow between these two species.

Even if the species studied showed significantly differentiated allele frequencies, no alternative allozymes were found which could demonstrate that gene flow does not occur between those two sibling species as it has been observed in other arthropods complexes (BULLINI 1982).

*

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PROSPECTS FOR EXTENDING THE USE OF AUSTRALIAN LACEWINGS IN BIOLOGICAL CONTROL

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Very few Australian lacewings have been utilised in biological control programmes, despite the need to manage an enormous variety of arthropod pests on a wide range of crops. Only two species (*Micromus tasmaniae* WALKER, *Mallada signatus* (SCHNEIDER)) have attracted wide attention. The reasons for this focus are discussed, and the biology and abundance of Australian Hemerobiidae and Chrysopidae reviewed as a basis for discovering further opportunities to manipulate native lacewing species for pest management. These opportunities are explored in the context of (1) the undesirability of introducing further exotic natural enemies to Australia and the consequent need to enhance use of native taxa, and (2) the characteristics of a 'good predator' for pest management.

Key words: pest management, natural enemies, predators, Neuroptera, Hemerobiidae, Chrysopidae

INTRODUCTION

The diversifying nature of integrated pest management continues to emphasise the need to employ all available natural enemies of agricultural pests. Continued introduction of exotic species into Australia for this purpose is questioned increasingly, on the grounds of environmental protection, and there has been renewed interest in improving the values of native natural enemies for pest management, with implications that the pool of suitable species may be considerably larger than those already being utilised. Within the Neuroptera, only single species of Hemerobiidae (*Micromus tasmaniae* WALKER) and Chrysopidae (*Mallada signatus* (SCHNEIDER)) have attracted wide attention as manipulable predators in Australia (HORNE *et al.* 2001*a, b*). Both families are diverse in Australia and have attracted considerable focus for biological control elsewhere in the world (NEW 1999). Opportunities to extend this predator spectrum in Australia initially seem to be available. The likelihood of utilising more Australian species of Neuroptera for pest management, as part of a transition from importing classical biological control agents to augmenting the use of available native species, is discussed in this paper.

CANDIDATE TAXA

The Australian Hemerobiidae includes 34 described species (NEW 1988), and Chrysopidae includes 60 species (NEW 1996). Most of these species, in both families, are poorly known. Some are scarce, or apparently scarce, and are known only from their types and from single localities. For many, no data are available on habitat tolerances and basic biology. Many appear to be geographically and/or ecologically restricted, for example to native forests in either the temperate or tropical parts of Australia.

The regions of greatest interest for agricultural pest management are the Bassian region and the central and central north parts of the east coast, where most field, orchard and forestry crops are produced. The spectrum of Hemerobiidae and Chrysopidae in these areas is considerably less than for Australia as a whole, and most of the species recorded are not common. Trap catches of lacewings in crops and natural environments in the region yield few common species, and few taxa are consistently present. Most catches are dominated by the two species noted above, *M. tasmaniae* and *M. signatus*.

However, at least three other species occur in reasonable abundance in the region, and at times in association with crops:

Hemerobiidae

Drepanacra binocula Newman is widespread in the region, although always markedly less abundant than *M. tasmaniae*. It is found predominantly on native vegetation such as *Acacia* trees (NEW 1984). It is a specialist feeder on Psylloidea. *D. binocula* occurs only rarely on field crops, but can be more common in orchards. All other Hemerobiidae are scarce, or occur only very sporadically on and around crops.

Chrysopidae

Plesiochrysa ramburi (SCHNEIDER) is very widespread in Australia and much of the western Pacific. It has been introduced to New Zealand from Australia on several occasions, but has not become established there (WISE 1995).

Apertochrysa edwardsi (BANKS) is sometimes the most abundant chrysopid on native vegetation in southern Australia (NEW 1983). As with *D. binocula*, it is

common on *Acacia*. It can by far outnumber other Chrysopidae in such natural habitats, but appears not to be strongly pre-adapted to native prey (NEW 1982).

Sporadic reports of other Australian Neuroptera on field crops or in association with pest arthropods occur – mainly in the north east, for *Mallada traviatus* (BANKS) (BOROS 1984), *M. basalis* (WALKER) and *Micromus timidus* HAGEN – but none has been noted as of potential economic value for crop protection in Australia. There are also very few 'early' records of lacewings as important predators. WILSON (1960) made no mention of hemerobiids in his review of biological control activities in Australia, and only casual note of *P. ramburi* and *M. signatus* in lists of purported natural enemies of scale insects. Neuroptera have been overshadowed substantially by Coccinellidae, whose predatory values have attracted much wider attention in Australia (FROGGATT 1902).

In New Zealand, *M. tasmaniae* and *D. binocula* are both indigenous, and regarded as long established from Australia (WISE 1995). Both have been implicated as important predators, the latter as 'the most important' predator of Homoptera on *Pittosporum* (CARTER 1949), although its incidence was too sporadic to effect control. Other New Zealand studies were summarised by WISE (1995). *D. binocula* was also exported from Australia to Hawaii for control of *Psylla* (=*Accizzia*) *uncatoides* on native *Acacia* species (LEEPER & BEARDSLEY 1976). Much earlier, *M. timidus* had also been introduced into Hawaii from Australia, to control sugarcane pests (WILLIAMS 1927). An initial stock of 14 living specimens from north Queensland was used to rear more than 5000 adults for release, together with numerous eggs. The lacewing established rapidly on several islands, and adults and larvae (as with *M. tasmaniae*) are both voracious predators.

By contrast with other parts of the world where Neuroptera are important biological control agents, Australia lacks members of the '*Chrysoperla carnea* group' of species so predominant in such activities. In Australia, *Chrysoperla* is represented by *Ch. congrua* (WALKER), a widespread species known from parts of northern and central Australia but absent from much of the east and south of the continent where needs for pest management are paramount. Many of the chrysopid genera in Australia have no historical involvement elsewhere in biological control operations. Likewise, most Hemerobiidae are not members of genera used widely in pest management (NEW 2001). The single Australian species of *Hemerobius*, for example, is poorly known, elusive, and its biology is unknown.

The 'pool' of candidate Neuroptera in Australia related to taxa manipulated elsewhere is thus genuinely small. Much original research would be needed to investigate their suitability for pest management and, even, to elucidate their basic biology. The more immediate priority is the enhancement of the effects of the two most abundant taxa, whose biology is reasonably well understood.

Established values of M. tasmaniae *and* M. signatus

These two species are among the most widely distributed lacewings in Australia (NEW 1997), and have been reported from all mainland states and Tasmania. *M. tasmaniae* and *M. signatus* are both generalist feeders and disperse readily on to low vegetation as a normal component of their habitats. Both features are important in biological control, in which a broad spectrum of management activities to enhance the impacts of natural enemies may be available. These include:

1. Multiple introductions, including augmentative releases of native species.
2. Reducing direct mortality by eliminating pesticide use, or seeking pesticide-resistant natural enemies.
3. Providing supplementary resources to attract or sustain natural enemies.
4. Increasing within-field and nearby vegetational diversity.
5. Manipulating features of the host plants.
6. Using semiochemicals (such as kairomones) to stimulate effective searching behaviour and selection of natural enemies in the field (after ALTIERI & NICHOLLS 1999).

The great majority of pest arthropods on Australian crops are exotic species, which have been present only during the recent period of European settlement, with new ones continuing to arrive and establish. Many are not closely related to native species, so that there is no predictable suite of pre-adapted specialist consumers. For example, Australia's few native aphid species are predominantly associated with forest environments, and virtually all the aphids on low vegetation are exotic species. Pest Lepidoptera include native noctuid moths, but others (such as *Pieris rapae* and *Plutella xylostella* on brassicas) are exotic. For these, and many other pests, biological control in Australia has relied heavily on the use of parasitoids. Use of native natural enemies, including predators, in IPM is relatively recent, together with associated mass rearing and dissemination of these.

The Coccinellidae commercially available in Australia are all predators of Homoptera. *Cryptolaemus montrouzieri*, *Rhyzobius lophanthae* and *Chilocorus* spp. are all recommended for use against mealybugs (*Cryptolaemus*) and various scale insects. The recommended pest target range for *M. signatus* is much broader, and indicates that it is one of the most effective generalist predators available on a commercial scale: aphids, two-spotted mite (*Tetranychus urticae*), greenhouse whitefly, scales, mealybugs, moth eggs and small caterpillars (PAPACEK *et al.* 1995). It is recommended also for use in a variety of contexts, including field crops, nurseries and greenhouses, and a considerable variety of crops in these environments.

M. signatus is available from two commercial facilities in Queensland, and is also reared elsewhere. *M. tasmaniae* has only recently become the focus of mass rearing studies, and has proved amenable to this (HORNE *et al.* 2001*a*); it is likely to receive considerably more attention in the next few years.

Both species are suitable for short term releases to increase impact of natural enemies over the life of a crop, with the underlying assumption of repeating the exercises in the future rather than relying on 'permanent' suppression of the pest. However, possibilities for conservation in crop environments and natural augmentation of both species by using food sprays and other attractants would seem to exist.

M . tasmaniae is recognised as a significant predator on aphids in New Zealand (ROHITHA & PENMAN 1986) and Australia (MILNE & BISHOP 1987). Both sexes disperse readily and, unusually for Hemerobiidae, the larvae are also mobile and descend from plants and traverse open ground to reach others. They are thus amenable to capture using pitfall traps, which have proved valuable in population assessment (RIDLAND 1988). The lacewing has been regarded as a 'key predator' of aphids (HORNE *et al.* 2001*b*), and its high tolerance to some pesticides led RUMPF *et al.* (1998) to believe it had 'high potential' in IPM in the region.

M. signatus is typically much less abundant than *M. tasmaniae* on field crops. Initial studies on its abundance in association with *Helicoverpa* caterpillars on cotton in Queensland (SAMSON & BLOOD 1979) suggested that it might be relatively more effective as a control agent than some analogous Chrysopidae employed widely in North America. More recently, it has been implicated in suppression of pest Lepidoptera on macadamia (Queensland) and grapevines (Victoria). However, more detailed studies of this very promising species are needed (HORNE *et al.* 2001*a*).

FUTURE DEVELOPMENTS

There has been a history of neglecting 'generalists' as biological control agents, with long-standing belief that feeding specificity is a key requirement for such natural enemies. However, this requirement is not as vital if native taxa are used within their natural ranges, rather than for exotic taxa being introduced into new ecological associations.

Very few studies (summarised by CHANG & KAREIVA 1999) have measured the contributions to biological control of generalist and specialist species on the same prey, and the results of these provide no general basis for recommendation. Non-target effects of native generalist predators may include decreasing numbers and impacts of specialist species, if these are also available. Conversely, as with

both the lacewing species discussed here, persistence in the local environment is likely (even, usual) during periods of low pest abundance when alternative foods are either present or provided as a component of management. They may then be regarded as 'lying in wait' (CHANG & KAREIVA 1999) and as 'insurance' against pest outbreaks. Refining management may lead to greatly increased reliance on such native generalist species in many pest management contexts.

The two species discussed here may have complementary roles, based on their size difference and the consequent differential vulnerability of different sizes of prey. *M. signatus* is able to take relatively larger caterpillars than *M. tasmaniae*, for example. Both species manifest many of the features of 'good' generalist predators. They occupy a large range of climatic regimes, and are easily manipulated in a variety of IPM contexts over much of the Australian continent, with local stocks likely to be available for enhancement. At present the limits to their use are not clear. The abundance of *M. tasmaniae* in the cooler regions of Australia and New Zealand implies that it could parallel some North American Hemerobiidae in being a useful control agent over the cooler parts of the year. *M. signatus* also breeds throughout the year, but is more abundant in the warmer seasons. Trials with artificial food sprays (MENSAH 1997) demonstrate the likelihood of effective population enhancement from local populations.

Both species are already regarded as valuable contributors to pest management on numerous crops, at a time when agricultural and horticultural diversification is an increasingly important strategy in Australia; and both are useful in both broad acre applications and more restricted environments. It is unlikely that their widespread use will be approached by any other lacewings in Australia, although *D. binocula* and *P. ramburi*, in particular, may have potential for development in some more specialised IPM contexts. At present there is little practical incentive to enhance the number of species of Neuroptera used as biological control agents in Australia and, apparently, few suitable candidate taxa with which to do so.

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NEUROPTERA OF WALLACEA: A TRANSITIONAL FAUNA BETWEEN MAJOR GEOGRAPHICAL REGIONS

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The central regions of Malesia, Wallacea, are the meeting place of the biota of two major geographical regions: Australia and the Oriental Region. Knowledge of the lacewings of Wallacea is reviewed, as an aid to assessing this faunal overlap and to understanding the origins and affinities of the Australian fauna. The constitution of the Malesian fauna of about 420 described species in 12 families is outlined, and the interacting faunas are tentatively appraised and defined.

Key words: zoogeography, Australasia, Oriental region, Malesia, lacewings

INTRODUCTION

Malesia, the complex area linking the Oriental and Australian biotas, is one of the most intriguing biogeographical regions in the world. Many biologists have speculated on the existence and positions of boundaries delimiting floral and faunal elements there, and compromise between the distributions of numerous groups of animals – each with different biology, dispersal abilities and ecological needs – for any generalisation has been difficult to find (SIMPSON 1977). The central transitional zone, Wallacea (Fig. 1), is of particular interest in seeking to clarify faunal transitions, as it is in this region of essentially Asian flora that a mixture of Asian and Australian related fauna is most clear. However, the concept of 'Wallacea' as a distinct region is by no means universally accepted (WHITTEN *et al.* 1988), because of the great complexity of the area and the presence of numerous endemic animals and plants. Thus, in relatively well known groups of insects such as papilionid and danaine butterflies (COLLINS & MORRIS 1985, ACKERY & VANE-WRIGHT 1984) endemism is sufficiently high to render the regional fauna of major global significance. Discussion of additional groups of fauna, especially lesser known ones, has potential to contribute to interpreting the complex overall picture of faunal relationships in the region. In this paper, a preliminary appraisal of the Neuroptera of Wallacea is provided particularly to indicate the putative presences, absences and constitution of major groups, and how these may affect interpretation of the Oriental or Australian faunas. A more comprehensive appraisal of the Malesian Neuroptera by NEW (2001) forms the framework for the following overview.

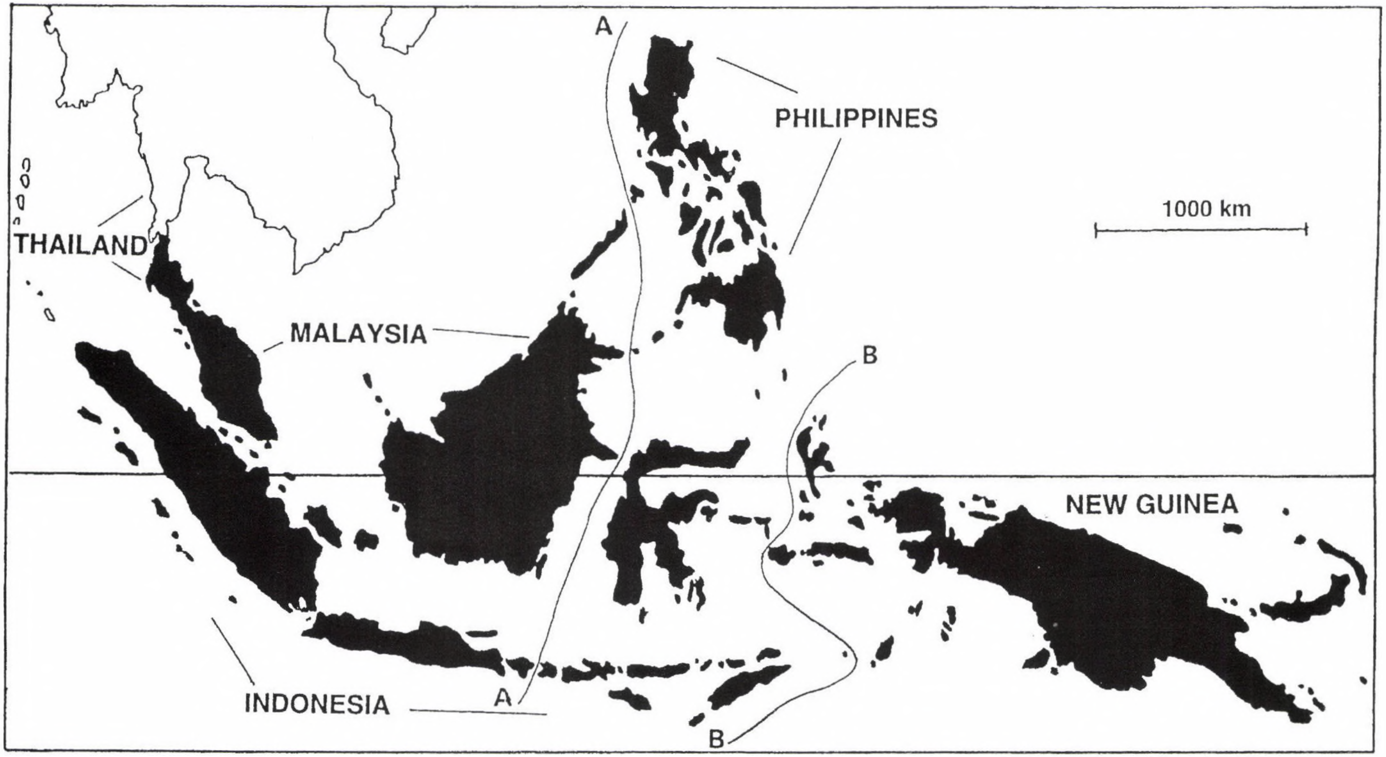


Fig. 1. Outline map of Malesia (black) with central region, Wallacea, delimited by WALLACE's line (A–A) and WEBER's line (B–B)

As with many other groups of insects, there are clear limitations to the reliability of information available. VAN DER WEELE's (1909) account remains the most comprehensive overview of the fauna of parts of Indonesia but the more limited region of Wallacea has not hosted resident neuropterists for any extended periods, and most of the few records of lacewings from the region are of material collected sporadically by non-specialists and described, with varying degrees of accuracy, by workers far distant from the region. Many of the early generic attributions have never been verified, and some assessments of distributions are compounded by labelling ambiguities: 'E. Ind.', for example has the ambiguity of "East Indies" or "East India". However, in recent years, I have tried to examine most of the species reported from the region, augmented by my own collections from parts of Papua New Guinea, Indonesia and Malaysia, with the primary focus of seeking to clarify the affinities of the diverse Australian fauna, and its transitions to the Oriental region.

The main features of the documented fauna are summarised in Table 1, which is based on published records and descriptions. For some groups, the perspective is likely to change considerably at the species diversity level. However, much of the Malesian region has been subject to massive environmental changes over the last century (MACKINNON 1997), predominantly through clearing of native vegetation for support of a burgeoning human population. MACKINNON (1997) claimed that more than 90% of the natural vegetation of the Philippines has

Table 1. Summary of recorded richness of families of Neuroptera in Wallacea, compared with Malesia

Family	No of species recorded from	
	Malesia	Wallacea
Rapismatidae	11	0
Coniopterygidae	59	7
Sisyridae	3	1
Osmylidae	56	8
Mantispidae	63	27
Berothidae	6	1
Dilaridae	3	0
Hemerobiidae	50	19
Chrysopidae	105	34
Nymphidae	9	1
Ascalaphidae	25	7
Myrmeleontidae	60	16

now been cleared for agriculture, logging and mining, for example, although figures for some parts of Indonesia are much less than this. Many of the elusive ecologically specialised taxa of lacewings and other insects have probably become even rarer than the few records suggest. It is perhaps doubtful that some of them are still extant, and anomalies in interpretation will inevitably persist for the foreseeable future. For some families, some of the nominal genera are apparently widely distributed in the region. For others, there is some evidence of 'skewed' incidence which may reflect attenuation from an area of origin to one or other side of Wallacea. However, knowledge of the source areas is itself uneven. A substantial framework is available for appraisal of the Australian fauna (NEW 1997), but many parts of western Malesia, continental south east Asia, and the Indian subcontinent are still relatively poorly documented. The extent of lacewing evolution on the complex archipelagos of Wallacea (essentially, southern and parts of eastern Indonesia, with Sulawesi the largest island, and the Philippines, excluding Palawan (note that many recent authorities now restrict the definition of Wallacea to exclude the Philippines [see COATES *et al.* 1997]) needs further investigation, together with elucidation of the dispersal powers of many taxa. Thus, for a related example, the lacewings recorded on the Krakatau Islands include several not normally considered to be competent dispersers (NEW & SUDARMAN 1988) or to occur in non-forested environments. A record of *Isoscelipteron nicobaricum* (NAVÁS) there was not only unexpected, but marked a considerable extension from the species' known range in Malaysia and the Nicobar Islands. A coniopterygid, *Heteroconis axeli* NEW, from the small patch of early successional *Casuarina* woodland on Anak Krakatau remains unknown elsewhere in Indonesia, despite the predominance of the genus in the regional fauna. Likewise, MONSERRAT's (1982) records of Coniopterygidae from Indonesia included some notable range extensions. Although the gross distributions of families and some major segregates of Neuroptera in the region are reasonably well understood, any synthesis at finer levels must remain tentative.

FAMILY REPRESENTATION AND RELATIVE DIVERSITY

The following families of Neuroptera have not been recorded from Wallacea or greater Malesia: Ithonidae, Rhachiberothidae, Nevrorthidae, Psychopsidae and Nemopteridae. Most of these are unambiguously absent, with the fauna clearly centred on other parts of the world, but two merit further investigation. Nevrorthidae and Psychopsidae are both known from Australia and regions to the north or west of Malesia, so that their known distributions are inexplicably disjunct. It is

possible that they occur in intervening zones, and the characteristic larvae of nevrorthids should be sought in running waters in the region. Nymphidae might also be found in Wallacea, as an attenuation from New Guinea, but it would indeed be surprising if such large and conspicuous insects as these and Psychopsidae have escaped notice until now.

Some other families are represented in Malesia by very few described species or other records, but are globally widespread. Few taxa of Sisyridae, Berothidae and Dilaridae have been described, with the last of these absent from Australia.

The remaining eight families are all well represented, and more diverse. They are thus the core taxa for more detailed faunal appraisal. The following notes refer to the Malesian fauna, as a basis for appraising the centre of this region.

DISTRIBUTION AND DIVERSITY OF MAJOR FAMILIES OF NEUROPTERA IN MALESIA

RAPISMATIDAE

The archaic Rapismatidae extend from northern India and Nepal, through Myanmar and West Malaysia to Borneo (BARNARD 1981), but their biology is unknown. Most species are known from very few individuals, and from single localities, and the family does not extend to the Australian Region. Their greatest richness is in West Malaysia. Not recorded from Wallacea, rapismatids are apparently restricted to the regions west of this. The Malesian species are clearly related to taxa from the Indian subcontinent and mainland south east Asia, and the family is absent from New Guinea and Australia. The narrowly endemic family is highly characteristic of the region and apparently limited to natural habitats, mainly at higher altitudes.

CONIOPTERYGIDAE

Most of the genera present in Malesia are widespread. *Heteroconis* ENDERLEIN is by far the most diverse genus, as it is in Australia. The suggestion by MEINANDER (1972) that Australian taxa might be generically distinct from Asian forms is not supported by the variety of species now known. Many *Heteroconis* species appear to have very restricted distributions in the region. The great diversity of *Heteroconis* is the most striking feature of the regional fauna, and this dominance is shared with Australia. *Heteroconis* occurs also in parts of Africa, but not

in the Palaearctic and much of south east Asia. It is most speciose in Indonesia, Papua New Guinea and Australia.

Paraconis MEINANDER is known only from Sabah, and may be an endemic Malesian genus, and should be sought in Wallacea. Most other genera are widespread, but the apparent lack of *Neosemidalis* ENDERLEIN, diverse in Australia and represented also in Papua New Guinea, emphasises the affinities of the genus as Australian. Likewise, *Cryptoscenea* ENDERLEIN is relatively poorly represented in Malesia (one record from Bali: MONSERRAT 1982) and more diverse in Australia. It may occur in Wallacea. *Coniocompsa* ENDERLEIN has not been reported from Australia and is more diverse elsewhere, including Africa.

OSMYLIDAE

Osmylidae of Malesia are characterised by massive radiation of Spilosmylinae and the absence or paucity of other subfamilies found in Australia and the eastern Palaearctic. *Spilosmylus* KOLBE is particularly diverse in Indonesia, the Philippines and Papua New Guinea, and it is likely that many further species await discovery there. The genus is scarcely represented in Australia. *Thaumatosmylus* KRÜGER appears to be restricted to western parts of Malesia, and has not been recorded from New Guinea.

The southern subfamilies predominant in the Australian fauna are absent. Spilosmylinae occur from Africa (TJEDER 1957) and India to northern Australia, where they are represented very poorly. Most of the species in the region appear to have rather narrow distributions, and Malesia is clearly a major centre for diversification of *Spilosmylus*. The two Australian species are known only from northern tropical Queensland, and represent attenuation from the diverse Malesian fauna.

MANTISPIDAE

The precise generic allocation of many of the complex array of taxa in this family remains uncertain. A few distinctive genera of large, wasp-like mantispids (*Campanacella* HANDSCHIN, *Mimetispa* HANDSCHIN) are known only from Malaysia and Indonesia, and others (such as *Eumantispa* OKAMOTO and *Euclimacia* ENDERLEIN) are distributed more widely in and around the region. Details of distribution of most taxa are unclear.

Three subfamilies are represented in Australia, but only Mantispinae are known from Wallacea. Many of the putative genera in Malesia do not occur in

Australia, and Australia and New Guinea share several genera which are unknown elsewhere. Some other Australian genera are apparently endemic (NEW 1998).

HEMEROBIIDAE

Few species of Hemerobiidae are common or widespread in the region, other than the very widely distributed *Micromus timidus* HAGEN. Broad-winged species of *Notiobiella* BANKS and *Psectra* HAGEN occur throughout the region, but are usually not common. *Hemerobius* L. is very poorly represented (except in the Philippines), and *Zachobiella* BANKS may be more diverse than presently documented.

Most genera found in Malesia are widespread, but several genera from Australia do not extend northward to the region. These are either confined to Australia (*Carobius* BANKS), where they may be Bassian (*Notherobius* NEW), or occur also in New Guinea. Others, such as *Wesmaelius* KRÜGER occur also in the eastern Palaearctic but have not been reported in Malesia. *Hemerobius* is also predominantly from the north, as evidenced by its apparently greatest regional diversity in the Philippines. The most characteristic genus in the region is *Zachobiella*, which ranges from south east Asia and New Guinea to Australia.

CHRYSOPIDAE

The large Apochrysinae are represented by three genera (*Joguina* NAVÁS, *Nobilinus* NAVÁS, *Synthochrysa* NEEDHAM) in Indonesia, but Chrysopinae is by far the more diverse subfamily. A number of regional species have not been attributed firmly to genus (BROOKS & BARNARD 1990), but *Glenochrysa* ESBEN-PETERSEN and *Kostka* NAVÁS are both characteristic taxa for the region. *Ankylopteryx* BRAUER s. l. is widely distributed, with some species rather variable (*A. octomaculata* (F.) and its 'forms'). *Italochrysa* PRINCIPI is also diverse. Nothochrysinae are absent, but represented by two genera in Australia. Two genera of Apochrysinae (*Joguina*, *Nobilinus*) are predominantly Malesian, with most described species of the latter from Indonesia. *Synthochrysa* is distributed more widely in the western Pacific. Affinities of most taxa of Chrysopinae are still confusing, as many of the genera are widely distributed to both 'sides' of Wallacea. *Kostka* is probably endemic to Malesia, and *Glenochrysa* (with several species undescribed) and sections of *Ankylopteryx* s. l. more diverse than elsewhere and shared with northern Australia.

ASCALAPHIDAE

Haplogleniinae are far less diverse in Malesia than are Ascalaphinae, in which the predominant genera appear to be *Ascalohybris* SZIRÁKI, *Suhpalacsa* LEFÈBVRE and *Suphalomitus* VAN DER WEELE. *Ascalohybris* occurs also in India, China and Taiwan, but is absent from Australia. The predominance of Suhpalacsini is a clear affinity with the Australian fauna, as all the Australian species belong to this tribe. However, many of the Australian genera are not known from nearby countries and may be endemic. *Suhpalacsa* and *Suphalomitus* are widespread in the region. The Haplogleniinae, a relatively minor component of the Malesian fauna (as *Idricerus* MCLACHLAN and *Protidricerus* VAN DER WEELE) show greater affinities with the Palaearctic fauna. *Helicomitus* MCLACHLAN (if a valid genus) is widespread in south east Asia.

MYRMELEONTIDAE

Some early records of Myrmeleontidae from Malesia are anomalous, and remain tantalising. Palparini (if present) and Acanthaclisinae are very poorly known, and most knowledge of antlions in the region is based on Myrmeleontinae. Myrmeleontini include the widely distributed group of species allied to *Myrmeleon acer* WALKER and several species of *Hagenomyia* BANKS. Protoplectrini is represented only by *Pseudoformicaleo* VAN DER WEELE. Distoleontini and Dendroleontini are the predominant tribes, with several genera of each widely distributed.

The few records of Palparini and Acanthaclisinae from Malesia are difficult to evaluate because of doubts over correct generic attributions. *Echthromyrmex* MCLACHLAN, although rare, is a clear affinity with the north and western fauna (such as the Indian subcontinent). Other palparines, if records of their incidence are indeed valid, represent attenuation from the African fauna. Palparines are absent from Australia.

The major groups of interest for zoogeographical appraisal are Dendroleontini and Distoleontini, the predominant tribes of antlions in Australia. Both are much more diverse in Australia than in neighbouring countries, but several genera are widespread, and correct placement of some Malesian taxa must await critical re-examination of the types. Some major species radiations, such as proliferation in the genera *Austrogymnocnemia* ESBEN-PETERSEN and *Glenoleon* BANKS are apparently confined to Australia. Some Australian genera (such as *Periclystus* GERSTAECKER) shared with New Guinea do not occur elsewhere. Both major genera of Myrmeleontini are widespread, with *Hagenomyia* limited to the far north in

Australia; *Callistoleon* BANKS is apparently absent from Malesia. The sole Malesian genus of Protoplectrini (*Pseudoformicaleo*) is widespread in the area, and shared with northern Australia; it has been recorded from Timor (HANDSCHIN 1937), and probably reflects an Australian lineage.

ENDEMISM AND FAUNAL DEFINITION

The above summaries indicate the overlap of the distinctive Australian fauna with that of south east Asia, and the differing extents to which this occurs in various lacewing families. However, the Neuroptera of central Malesia, Wallacea, are extremely poorly documented. The region is geographically complex, with considerable discussion since DICKERSEN *et al.*'s (1928) definition of the area to include the Philippines. At present, only about 15 species of Neuroptera are known from both southern Indonesia and the Philippines, and most of these occur more widely in Malesia. Three major groups of islands form Indonesian Wallacea and form the basis of distinctive subregions as (a) Sulawesi and its neighbours, (b) the Moluccas and (c) the Lesser Sunda Islands. The overall regional complexity is manifest by VAN STEENIS' (1972) appraisal of the putative origins of Sulawesi's allochthonous mountain flora, with three main tracks of (a) Luzonian, southward from the Asian mainland through the Philippines, (b) Sumatran, eastward from Malaysia through Sumatra and Java, and extending through the Lesser Sundas, and (c) Papuan, westward from Melanesia through New Guinea. Faunal origins are similarly complex, with each contributing to development of endemic (or autochthonous) taxa after establishment. Some broad parallels between Neuroptera and plant tracks could be suggested; the apparent diversity of *Hemerobius* in the Philippines, for example, may represent their southward extension from Asia that has not reached Sulawesi. However, even for Sulawesi, few recent records of lacewings exist, and knowledge of the complex Philippines fauna has scarcely been augmented since the descriptive accounts by BANKS (1916, 1937, 1939). Many of the Indonesian islands lack records of Neuroptera, and the most recent synoptic publications are by HANDSCHIN (1935, 1937). Table 1 reveals records for only about 120 species (of a Malesian total of about 420) in 10 families (of 12 in Malesia). The Philippines total of 80 species considerably exceeds the 54 notional species reported from Wallacean Indonesia, and the latter region has been substantially undersampled in relation to Irian Jaya and the main western islands of Indonesia. In particular, the apparent paucity of *Heteroconis* and *Spilosmylus* in relation to other parts of Malesia is unlikely to be realistic.

Neuroptera of Wallacea do not appear to constitute a distinctive faunal unit above the species level, but include elements that are (a) widely distributed in Malesia, (b) predominantly Australian in relationships, a trend evident particularly for areas close to Australia, such as Timor, or (c) more clearly aligned with the south east Asian fauna. The broader regional fauna is more distinctive, but the extent to which this picture is realistic – or can be augmented meaningfully – is clearly open to doubt. Overall, Sulawesi is not as biologically diverse as Borneo, but both it and the Philippines have high levels of species endemism. It is reasonable to suppose that further endemic lacewings await discovery in the remaining less disturbed parts of Wallacea.

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Checklist of the Diptera of Hungary

Edited by L. Papp

This is an international undertaking of 20 authors: a checklist of the dipterous species found through the end of 2000 in Hungary, with references to their first reliable records in the territory of modern Hungary. The "minimum requirements" for a "first record" are to have the name of the identifier and the place of deposition, and to have evidence that the site is a locality of present-day Hungary. The starting point for most parts is Thalhammer's Fauna Regni Hungariae in 1900 and every family part has a short introduction. These parts contain data on the number of recorded species and on the number of species expected to occur in Hungary. Most of the voucher specimens are deposited in the Diptera collection of the Department of Zoology, Hungarian Natural History Museum, Budapest (HNHM); in exceptional cases the name of the relevant institution is given. There are numerous species new to Hungary reported here for the first time, however, the dipterous fauna of Hungary is still poorly known with 5550 species in this book. According to our present knowledge no less than 10000 species may occur in the country.

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ZOOGEOGRAPHICAL PATTERNS IN CHRYSOPIDAE OF THE MADAGASCAN SUBREGION (INSECTA: NEUROPTERA)

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Fifty four species and subspecies of Chrysopidae have been recorded from the Madagascan subregion. Thirty seven are probably endemic to the subregion, seventeen are more widely distributed: nine occur throughout sub-Saharan Africa,six have only been found in Eastern Africa, while two species occur throughout the continent and extend eastwards as far as the Pacific region. Two of the endemic species, *Dichochrysa duplicata* and *Glenochrysa insularis* are represented in the subregion by three subspecies each.
The origin of most of the endemic species seems to be Africa south of the Sahara. Only two *Plesiochrysa* species from the Seychelles belong to the "*oceanica*-group" of *Plesiochrysa*, that is not known from Africa but from the Oriental region.
In addition to the distance from the continent of Africa, Madagascar, and the varying sizes and altitudes of the islands, the varying number of known species from different islands is due to the disparate amounts of work done on them. The Seychelles, Mauritius, La Réunion, Mayotte, and Grande Comore where visited several times, Moheli and Rodriguez for a few days only, while we only know of older reports from Madagascar and Anjouan.

Key words: Chrysopidae, Madagascan region, distribution, biogeography

INTRODUCTION

The islands of the Madagscan subregion have different origins (Fig. 1). Madagascar and the rocky islands of the Seychelles are fragments of the former continent of Gondwanaland. The archipelagos of the Mascarenes as well as the Comoros are of volcanic origin, the easternmost island in each archipelago being the oldest and lowest, the westernmost the youngest and highest with active volcanoes. Furthermore, there are numerous coral reefs, partly covered with sand cays that do not rise more then a few metres above sea level. Most of them are situated north of Madagascar, with the volcanic archipelagos being part of the Republic of the Seychelles. All islands are situated within the tropics, between 3° and 26°S.

The first report on a Chrysopid from the Madagascan subregion was by BURMEISTER (1839), who described *Chrysopa variegata* from the Comoros. In 1842, RAMBUR described *Chrysopa brevicollis* from Mauritius. (*Chrysopa mauricianus* RAMBUR from Mauritius is a synonym of the Palaearctic *C. pallens*, the citing being incorrect). VAN DER WEELE (1909*b*) described *Leucochrysa voeltzkowi* from

Mayotte and named *C. congrua* from Moheli. Between 1908 and 1940, NAVÁS described 34 species from the subregion: 19 were later synonymised. In addition, he recorded several new localities.

The first survey of the islands (ESBEN-PETERSEN 1927) listed 13 chrysopids from the Seychelles. He described *C. scotti*, *C. lauta* and four species that were later identified as synonyms. TJEDER (1966) recognised several synonyms. FRASER (1951) described four new species from Madagascar and named only seven Chrysopidae in an overview of all Neuroptera known from Madagascar at that time. In 1952 he described *Ankylopteryx tanana* from the same island, and 1957 he added

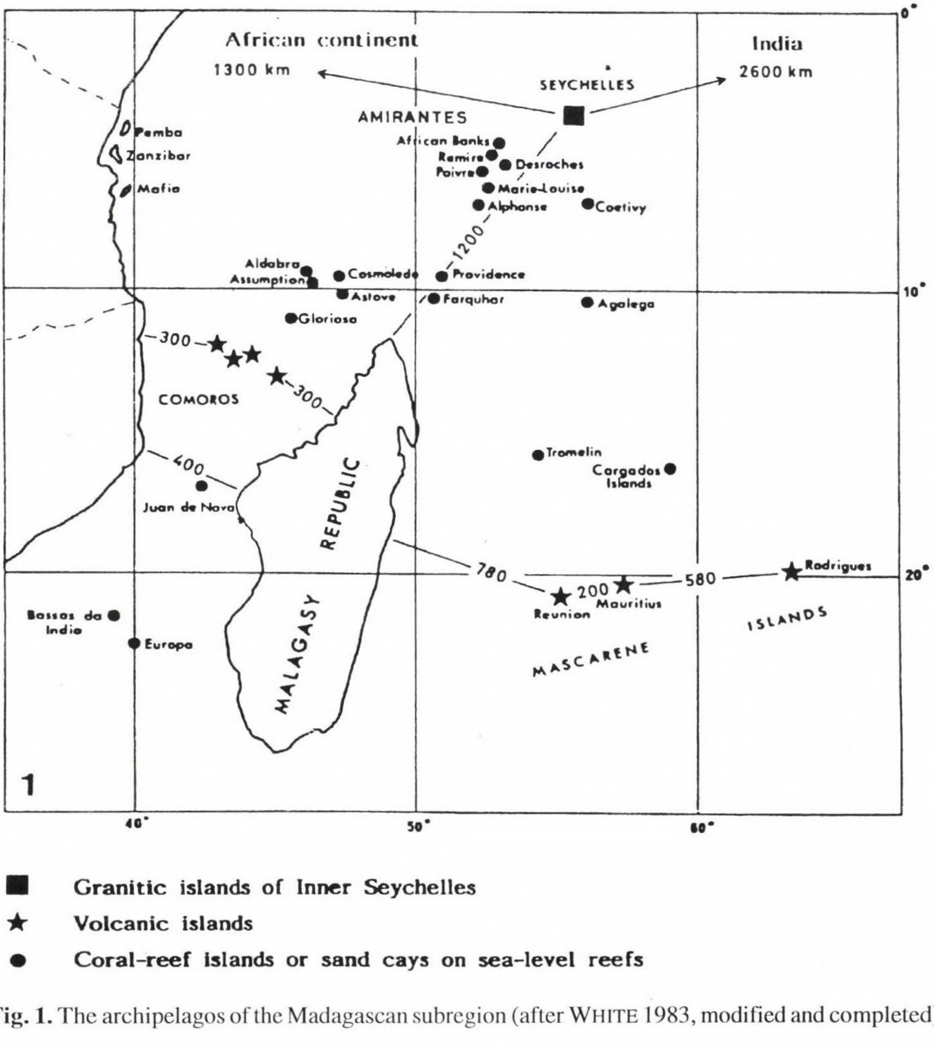


Fig. 1. The archipelagos of the Madagascan subregion (after WHITE 1983, modified and completed)

Chrysopa insulata from La Réunion. SÉMÉRIA and QUILICI (1986) reported collection dates of six species from the same island. HÖLZEL and DUELLI (1990) provided a general review of all 31 described nominal species from Madagascar and recorded collecting dates of nine species from the island.

In 1992, HÖLZEL and OHM published an overview of 39 chrysopid species from the whole Madagascan subregion and recognised numerous synonyms. Since then, the Seychelles, Mascarene islands La Réunion, Mauritius and Rodriguez, as well as the Comoro islands Grande Comore, Moheli and Mayotte have been visited several times by one or both authors. New species have been described and new synonyms recognised (HÖLZEL 1991, 1992, HÖLZEL & OHM 1991, 1995, 2000, OHM & HÖLZEL 1995, 1997, 1998). Only Madagascar and the Comoro island of Anjouan, where not visited, and Moheli was only investigated for a few days. These visits greatly increased our knowledge of the composition and distribution patterns of the Madagascan chrysopid fauna.

The material used in this study (partly unpublished) is deposited in the collections of H. HÖLZEL, P. OHM and CIRAD St. Pierre/La Réunion (S. QUILICI & J. F. VAYSSIERES). On a few occasions, on the islands of La Réunion, Moheli and Grande Comore, we found single females and one immature male, apparently belonging to undescibed species.

All literature pertaining to the family Chrysopidae in the Madagascan subregion is cited here. Records of localities from the African continent can be found in recent compilations that are also cited.

CATALOGUE OF CHRYSOPIDAE OF THE MADAGASCAN SUBREGION

Subfamily APOCHRYSINAE

Anapochrysa voeltzkowi (VAN DER WEELE, 1909)

Leucochrysa voeltzkowi VAN DER WEELE, 1909*a*: 67 (odescr); FRASER 1951 (distr).
Oligochrysa voeltzkowi (VAN DER WEELE): ESBEN-PETERSEN 1927 (comb, list).
Anapochrysa africana KIMMINS, 1952: 933 (odescr); TJEDER 1966 (redescr); HÖLZEL & OHM 1992 (syn).
Anapochrysa voeltzkowi (VAN DER WEELE): HÖLZEL & DUELLI 1990 (comb); HÖLZEL & OHM 1992 (syn, distr); OHM & HÖLZEL 1998 (distr).

Madagascar and the Comoro islands Mayotte, Moheli and Grande Comore; on the continent from the Western Cape Province northward to Kenya and Sao Thomé (TJEDER 1966, OHM & HÖLZEL 1998).

Subfamily CHRYSOPINAE
Tribe Ankylopterygini

Ankylopteryx alluaudi NAVÁS, 1910

Ancylopteryx alluaudi NAVÁS, 1910: 50 (odescr); ESBEN-PETERSEN 1927 (list, distr).
Ankylopteryx alluaudi NAVÁS: HÖLZEL & OHM 1992 (distr, list); OHM & HÖLZEL 1995 (distr).
Ancylopteryx delicata NAVÁS, 1935: 62 (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL 1992 (syn).
Leucochrysa octopunctata FRASER, 1951: 26 (odescr); HÖLZEL & DUELLI 1990 (comb, distr); HÖLZEL 1992 (syn)

Found on the central Seychelles islands Mahé, Silhouette, La Digne and on Madagascar.

Ankylopteryx pallidula TJEDER, 1966

Ankylopteryx pallidula TJEDER, 1966: 501 (odescr); HÖLZEL 1992 (syn); OHM & HÖLZEL 1998 (distr).
Ankylopteryx pellucida TJEDER, 1966: 502 (odescr); HÖLZEL 1992 (syn).
Ankylopteryx grata TJEDER, 1966: 504 (odescr); HÖLZEL 1992 (syn).

Comoro islands Mayotte, Moheli and Grande Comore; in Eastern Africa known from Kwa Zulu Natal, Mpumulanda, Mozambique (TJEDER 1966) Tanzania and Ethiopia (HÖLZEL *et al.* 1999) (see Fig. 2).

Ankylopteryx tanana FRASER, 1952

Ankylopteryx tanana FRASER, 1952: 142 (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL 1992 (list); HÖLZEL & OHM 1992 (distr, list).

Only known from Madagascar.

Parankylopteryx multipunctata (FRASER, 1951)

Leucochrysa multipunctata FRASER, 1951: 29 (odescr); HÖLZEL & DUELLI 1990 (list).
Parankylopteryx multipunctata (FRASER): BROOKS & BARNARD 1990 (comb); HÖLZEL 1992 (list); HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Tribe Belonopterygini

Chrysacanthia varicella (FRASER, 1951)

Nesochrysa varicella FRASER, 1951: 29 (odescr); HÖLZEL & DUELLI 1990 (list)
Glenochrysa varicella (FRASER): FRASER 1950 (comb).
Chrysacanthia varicella (FRASER): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Italochrysa boueti (NAVÁS, 1927)

Nothochrysa boueti NAVÁS, 1927: 24 (odescr); HÖLZEL & DUELLI 1990 (list).
Nothochrysa cruciata NAVÁS, 1935: 63 (odescr); HÖLZEL & OHM 1992 (syn).
Italochrysa boueti (NAVÁS): HÖLZEL & DUELLI 1990 (comb); HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

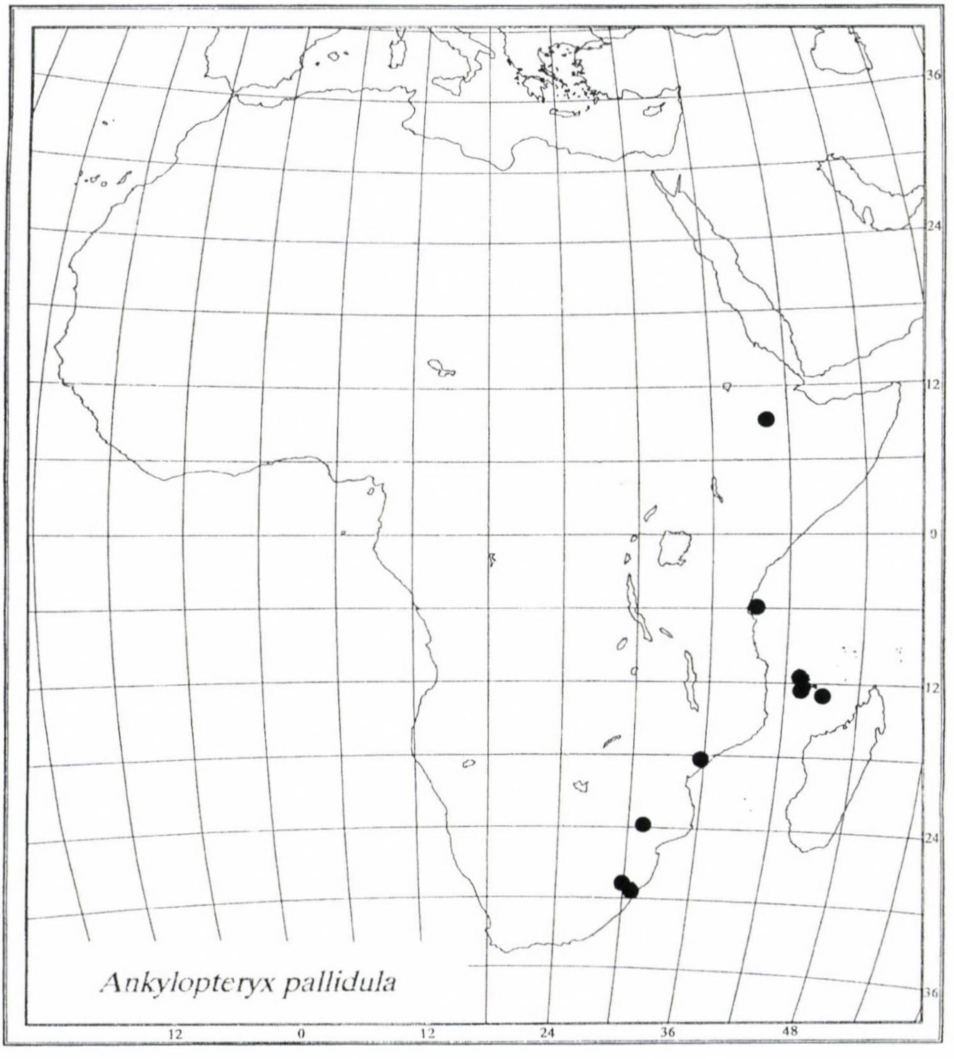


Fig. 2. Recorded distribution of *Ankylopteryx pallidula* TJEDER

Italochrysa limbata (NAVÁS, 1924)

Nothochrysa limbata NAVÁS, 1924: 113 (odescr).
Nothochrysa cornuta NAVÁS, 1935: 64 (odescr); HÖLZEL & DUELLI 1990 (comb); HÖLZEL & OHM 1992 (syn).
Italochrysa limbata (NAVÁS): HÖLZEL & DUELLI 1990 (comb); HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Italochrysa madagassa HÖLZEL et OHM, 1995

Italochrysa sp. HÖLZEL & OHM 1992 (list).
Italochrysa madagassa HÖLZEL & OHM, 1995: (odescr).

Only known from Madagascar.

Italochrysa nossibensis (NAVÁS, 1928)

Nothochrysa nossibensis NAVÁS, 1928: 113 (odescr).
Italochrysa nossibensis (NAVÁS): HÖLZEL & DUELLI 1990 (comb); HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Italochrysa variegata (BURMEISTER, 1839)

Chrysopa variegata BURMEISTER, 1839: 981 (odescr).
Nothochrysa variegata (BURMEISTER): ESBEN-PETERSEN 1927 (comb, list).
Nothochrysa sordidata NAVÁS, 1908: 404 (odescr); ESBEN-PETERSEN 1927 (syn); HÖLZEL & DUELLI 1990 (list).
Italochrysa sordidata (NAVÁS): BROOKS & BARNARD 1990 (comb).
Italochrysa variegata (BURMEISTER): TJEDER 1996 (redescr, comb, distr); HÖLZEL & OHM 1992 (list); OHM & HÖLZEL 1998 (distr).

Madagascar and the Comoro island Anjouan; in Eastern Africa from South Africa to Ethiopia (HÖLZEL, OHM & DUELLI 1999).

Nesochrysa grandidieri NAVÁS, 1910

Nesochrysa grandidieri NAVÁS, 1910: 53 (odescr); ESBEN-PETERSEN 1927 (list); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (list).
Madachrysa seyrigi NAVÁS, 1934: 62 (odescr); FRASER 1955 (fig); TJEDER 1973 (redescr, distr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).

Only known from Madagascar.

Nesochrysa marginata (NAVÁS, 1912)

Leucochrysa marginata NAVÁS, 1912: 100 (odescr); ESBEN-PETERSEN 1927 (list).
Nesochrysa marginata (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Tribe Chrysopini

Apertochrysa eurydera (NAVÁS, 1910)

Chrysopa eurydera NAVÁS, 1910: 43 (odescr); ESBEN-PETERSEN 1927 (list); HÖLZEL & DUELLI 1990 (list).
Chrysopa madegassa NAVÁS, 1921: 69 (odescr); ESBEN-PETERSEN 1927 (list); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).
Chrysopa ictericus ESBEN-PETERSEN, 1927: 450 (odescr); HÖLZEL & OHM 1992 (syn).
Chrysopa crassinervis ESBEN-PETERSEN, 1927: 452 (odescr); HÖLZEL & OHM 1992 (syn).
Apertochrysa sp.: HÖLZEL & DUELLI 1990 (distr).
Apertochrysa eurydera (NAVÁS): HÖLZEL & OHM 1991b (distr), 1992 (comb, distr), ; OHM & HÖLZEL 1995 (distr), 1997 (distr), 1998 (distr).

Seychelles: central islands Mahé, Silhouette and Praslin; on coral reefs of Amirantes (D'Arros Isl.) and Aldabra (Isl. Picard). Macarene islands Rodriguez, Mauritius and La Réunion; Madagascar and the Comoro islands Mayotte, Moheli and Grande Comore. On the continent from South Africa northward to Senegal and Somalia (HÖLZEL *et al.* 1997).

Borniochrysa squamosa (TJEDER, 1966)

Chrysopa (Suarius) squamosa TJEDER, 1966: 377 (odescr).
Suarius squamosus (TJEDER): SÉMÉRIA & QUILICI 1986 (comb, distr); HÖLZEL & DUELLI 1990 (distr).
Borniochrysa squamosa (TJEDER): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1991*b* (distr), 1992 (list); OHM & HÖLZEL 1995 (distr), 1997 (distr), 1998 (distr).

Mascarene islands Mauritius and La Réunion; Madagascar and the Comoro islands Mayotte and Grande Comore. In the Eastern part of the continent from the Western Cape Province to Ethiopia (HÖLZEL *et al.* 1999) in Western Africa only known from Senegal (HÖLZEL *et al.* 1994); St. Helena (TJEDER 1976) (see Fig. 3).

Brinckochrysa lauta (ESBEN-PETERSEN, 1927)

Chrysopa lauta ESBEN-PETERSEN, 1927: 451 (odescr); HÖLZEL & OHM 1992 (list).
Neda decaryella NAVÁS, 1933*a*: 106 (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).
Neda pictella NAVÁS, 1933*a*: 107 (odescr); HÖLZEL & OHM 1992 (syn).
Chrysopa sobria NAVÁS, 1933*b*: 110 (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).
Chrysopa goniophora NAVÁS, 1935: 59 (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).
Chrysopa (Brinckochrysa) michaelseni auct. (nec ESBEN- PETERSEN): TJEDER 1966 part., fig. 1247–1253 (distr).
Brinckochrysa spec.: SÉMÉRIA & QUILICI 1986 (distr).
Brinckochrysa goniophora (NAVÁS): BROOKS & BARNARD 1990 (comb): HÖLZEL & DUELLI 1990 (distr); HÖLZEL & OHM 1992 (syn).
Brinckochrysa decaryella (NAVÁS): BROOKS & BARNARD1990 (comb); HÖLZEL & OHM 1991b (distr), 1992 (syn).

Brinckochrysa lauta (ESBEN-PETERSEN): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list); OHM & HÖLZEL 1995 (syn, distr), 1997 (distr), 1998 (distr).

Central Seychelles islands Mahé and Long Island; Mascarene islands Mauritius and La Réunion; Madagascar and Mayotte. Outside the Madagascan region found only once in Kwa Zulu Natal.

Brinckochrysa pulchella HÖLZEL, 1987

Brinckochrysa pulchella HÖLZEL, 1987: 266 (odescr); HÖLZEL & OHM 1992 (distr).

Madagascar; on the continent in South Africa (HÖLZEL 1987) and Namibia (HÖLZEL *et al.* 1997).

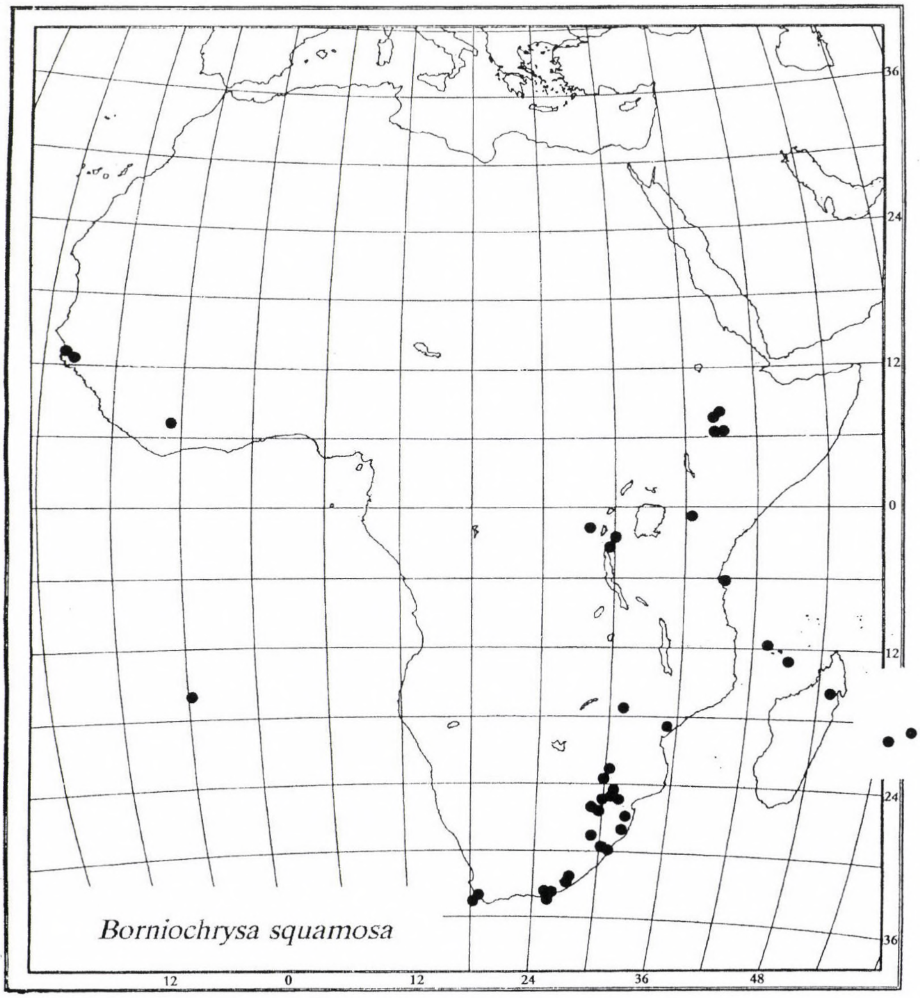


Fig. 3. Recorded distribution of *Borniochrysa squamosa* (TJEDER)

Brinckochrysa stenoptera (NAVÁS, 1910)

Chrysopa stenoptera NAVÁS, 1910: 46 (odescr).
Chrysopa (Brinckochrysa) stenoptera (NAVÁS): TJEDER 1966 (redescr., comb, distr).
Brinckochrysa stenoptera (NAVÁS): HÖLZEL 1987 (comb, syn, distr); HÖLZEL & OHM 1992 (distr).

Madagascar; on the continent known from Western Cape Province to Northern Province, Zimbabwe, Mocambique and Somalia, in Namibia, Nigeria, Gambia and Senegal (TJEDER 1966, HÖLZEL 1987, HÖLZEL & OHM 1991a, HÖLZEL, OHM & STELZL 1994).

Ceratochrysa antica (WALKER, 1853)

Chrysopa antica WALKER, 1853: 270 (odescr).
Chrysopa nesaea NAVÁS, 1911: 268 (odescr); ESBEN-PETERSEN 1927 (list); BARNARD & BROOKS 1984 (syn).
Chrysopa inaequalis NAVÁS, 1912: 103 (odescr); ESBEN-PETERSEN 1927 (syn); BARNARD & BROOKS 1984 (syn).
Ceratochrysa antica (WALKER) BARNARD & BROOKS 1984 (redescr, thorough syn, distr); HÖLZEL & Dueli 1990 (distr); HÖLZEL & OHM 1991*b* (distr), 1992 (list); OHM & HÖLZEL 1997 (distr), 1998 (distr).

Mascarene islands Mauritius and La Réunion, on Madagascar and the Comoro islands Mayotte, Moheli and Grande Comore. In Eastern Africa from Northern Province, South Africa to Uganda, in Western Africa from Namibia to Senegal (BARNARD & BROOKS 1984, HÖLZEL, OHM & STELZL 1994, 1997).

Ceratochrysa disparilis (NAVÁS, 1934)

Cintameva disparilis NAVÁS, 1934: 61 (odescr).
Ceratochrysa disparilis (NAVÁS): BARNARD & BROOKS 1984 (redescr, comb, distr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (list).

Only found on Madagascar.

Chrysemosa umbralis (NAVÁS, 1933)

Chrysopa umbralis NAVÁS, 1933*a*: 211 (odescr).
Suarius umbralis (NAVÁS): HÖLZEL & DUELLI 1990 (comb, distr).
Chrysemosa umbralis (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1991*b* (distr), 1992 (list); OHM & HÖLZEL 1997 (distr), 1998 (distr).

Known from the Mascarene islands Mauritius and La Réunion; from Madagascar and the Comoro islands Mayotte, Moheli and Grande Comore (see Fig. 4).

Chrysoperla brevicollis (RAMBUR, 1842)

Chrysopa brevicollis RAMBUR, 1842: 427 (odescr).
Chrysoperla brevicollis (RAMBUR): HÖLZEL & OHM 1991*b* (distr), 1992 (list); OHM & HÖLZEL 1997 (tax, distr), 1998 (distr).
Chrysoperla pudica auct.(nec NAVÁS): BROOKS 1994 (tax).

Only known from the Mascarene islands Mauritius and La Réunion.

Chrysoperla congrua (WALKER, 1853)

Chrysopa congrua WALKER, 1853: 238 (odescr); VAN DER WEELE 1909b (distr); FRASER 1951 (distr). *Chrysopa acutella* NAVÁS, 1933*b*: 209 (odescr); HÖLZEL 1989 (syn); HÖLZEL & DUELLI 1990 (list).

Chrysoperla congrua (WALKER): SÉMÉRIA & QUILICI 1986 (distr); HÖLZEL & OHM 1992 (list); OHM & HÖLZEL 1997 (distr), 1998 (distr).

In the subregion found on La Réunion, Madagascar, Anjouan and Moheli. On the continent spread from the Western Cape Province to Principe Islands and Sierra Leone, in Eastern Africa northward to the Republic of Sudan (HÖLZEL & OHM 1991*a*), in Arabia in Oman and Yemen (HÖLZEL 1995) and on islands in the Pacific Ocean (BROOKS 1994).

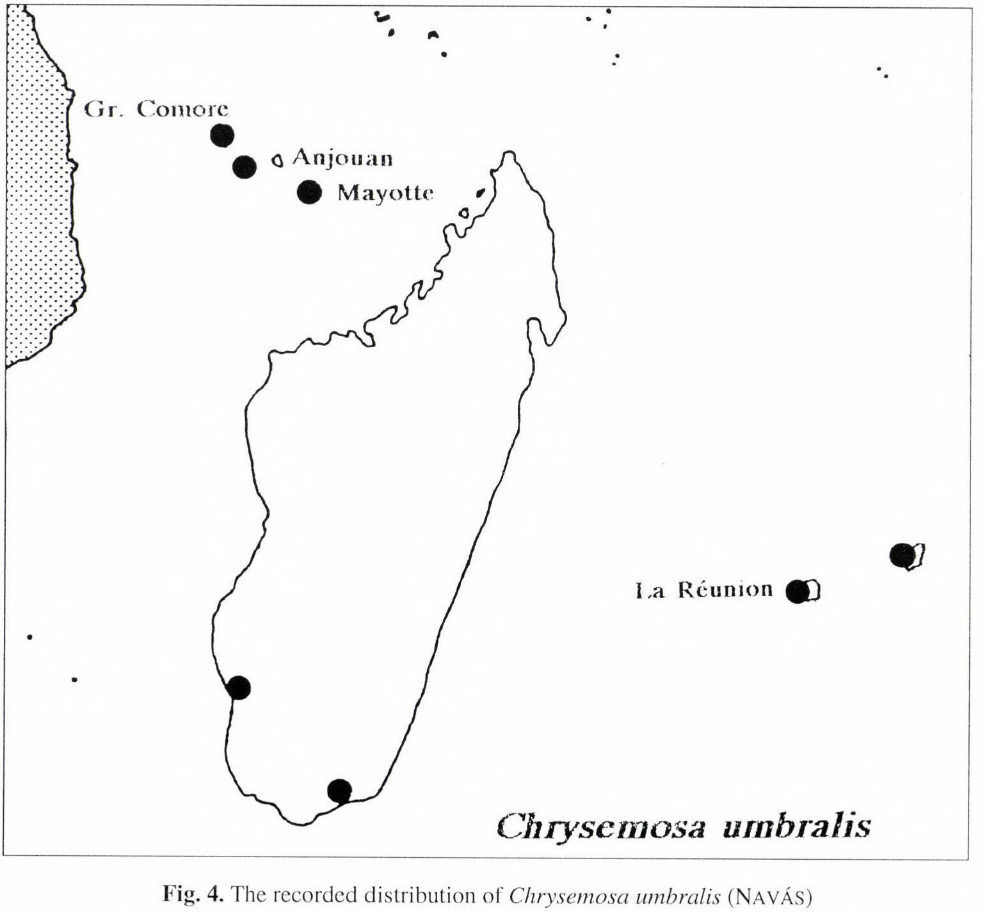


Fig. 4. The recorded distribution of *Chrysemosa umbralis* (NAVÁS)

Chrysoperla decaryana (NAVÁS, 1934)

Chrysopa decaryana NAVÁS, 1934: 60 (odescr); HÖLZEL & DUELLI 1990 (list).
Chrysoperla decaryana (NAVÁS): HÖLZEL 1989 (redescr, comb); HÖLZEL & OHM 1992 (list); BROOKS 1994 (tax).

Known only from Madagascar.

Chrysoperla insulata (FRASER, 1957)

Chrysopa insulata FRASER, 1957: 26 (odescr).
Chrysoperla insulata (FRASER): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1991*b* (distr), 1992 (list); BROOKS 1994 (tax); OHM & HÖLZEL 1997 (distr).

Known only from La Réunion.

Chrysoperla volcanicola HÖLZEL, OHM et DUELLI, 1999

Chrysoperla volcanicola HÖLZEL, OHM et DUELLI 1999: 355 (odescr).

Grande Comore; on the continent known from Ethiopia.

Dichochrysa decaryna (NAVÁS, 1924) – **comb. n.**

Chrysopa decaryna NAVÁS, 1924: 267 (odescr)
Mallada decaryna (Navas): HÖLZEL & DUELLI 1990 (distr).
Mallada decarynus (NAVÁS): HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Dichochrysa duplicata duplicata (NAVÁS, 1934)

Chrysopa duplicata NAVÁS, 1934: 57 (odescr); HÖLZEL & DUELLI 1990 (list) .
Chrysopa diploa NAVÁS, 1935: 60 (odescr); HÖLZEL & OHM 1992 (syn).
Mallada diploa: HÖLZEL & DUELLI 1990 (comb, distr).
Mallada duplicata (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1991 (distr); 1992 (list).
Dichochrysa duplicata duplicata (NAVÁS): HÖLZEL & OHM 2000 (tax, distr).

The subspecies is known only from Madagascar (see Fig. 5).

Dichochrysa duplicata mascarenica HÖLZEL et OHM, 2000

Mallada duplicata (NAVÁS): HÖLZEL & OHM 1991*b* (distr).
Dichochrysa duplicata (NAVÁS): OHM & HÖLZEL 1997 (comb, distr).
Dichochrysa duplicata mascarenica HÖLZEL & OHM, 2000 (stat., odescr).

The subspecies is known from the Mascarene Inslands La Réunion and Mauritius (see Fig. 5)

Dichochrysa duplicata polyneura (NAVÁS, 1940)

Cintameva polyneura NAVÁS, 1940: 100 (odescr).

Mallada polyneurus (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list).
Dichochrysa duplicata NAVÁS: OHM & HÖLZEL 1998 (distr).
Dichochrysa duplicata polyneura (NAVÁS): HÖLZEL & OHM 2000 (stat, redescr).

The subspecies is known from the Comoro Islands Mayotte, Moheli and Grande Comore (see Fig. 5).

Dichochrysa hamata (TJEDER, 1966) – **comb. n.**

Chrysopa (Anisochrysa) hamata TJEDER, 1966: 434 (odescr).
Mallada hamatus (TJEDER): HÖLZEL & DUELLI 1990 (distr); HÖLZEL & OHM 1992 (list).

In the subregion on Madagascar, on the continent from Kwa Zulu Natal (TJEDER 1966) and Northern Province of South Africa (unpubl.).

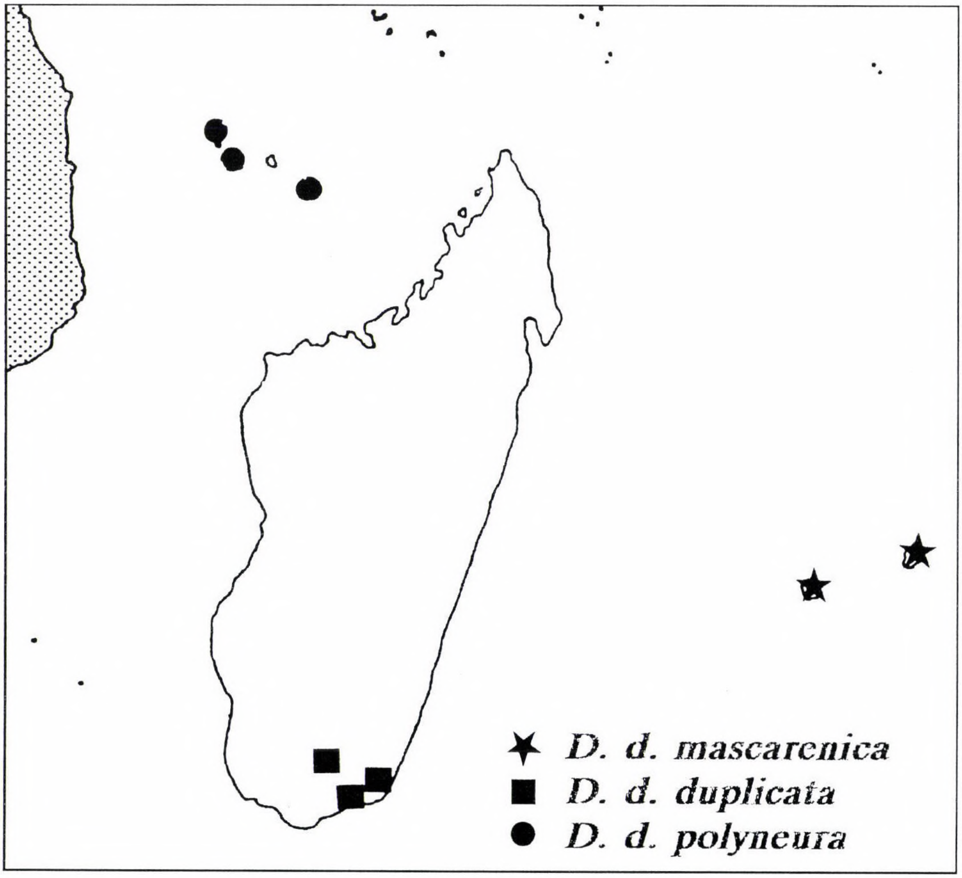


Fig. 5. The subspecies of *Dichochrysa duplicata* (NAVÁS)

Dichochrysa handschini (NAVÁS, 1929)

Chrysopa handschini NAVÁS, 1929*b*: 444 (odescr).
Cintameva alluaudi NAVÁS, 1930: 8 (odescr); HÖLZEL & OHM 1992 (syn).
Chrysopa (Anisochrysa) handschini (Navas): TJEDER 1966 (redescr, distr).
Mallada handschini (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list).
Dichochrysa handschini (NAVÁS): HÖLZEL & OHM 1997 (comb, distr).

In the subregion known from Mauritius; in Eastern Africa from the Western Cape Province to Ethiopia (HÖLZEL *et al.* 1999).

Dichochrysa hospitalis HÖLZEL et OHM, 1994

Dichochrysa hospitalis HÖLZEL & OHM, 1995 (odescr); OHM & HÖLZEL 1998 (distr).

Only known from the Comoro Islands Mayotte and Grande Comore.

Dichochrysa incongrua (FRASER, 1951) – **comb. n.**

Chrysopa incongrua FRASER, 1951: 25 (odescr); HÖLZEL & DUELLI 1990 (list).
Mallada incongrua (FRASER): BROOKS & BARNARD 1990 (comb).
Mallada incongruus (FRASER): HÖLZEL & OHM 1992 (list).

Only known from Madagascar.

Dichochrysa inopinata HÖLZEL et OHM, 1995

Mallada hamatus auct. (nec TJEDER): HÖLZEL & OHM 1990 (distr), 1992 (list).
Dichochrysa inopinata HÖLZEL & OHM, 1995: 113 (odescr); OHM & HÖLZEL 1997 (distr).

Only known from La Réunion.

Dichochrysa luaboensis (TJEDER, 1966) – **comb. n.**

Chrysopa (Anisochrysa) luaboensis TJEDER, 1966: 457 (odescr).
Mallada luaboensis (TJEDER): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (distr).

Known from Madagascar; on the continent from Mozambique (TJEDER 1966) and Equatorial Guinea (HÖLZEL & MONSERRAT 1992).

Dichochrysa mauriciana (HÖLZEL et OHM, 1991)

Mallada mauricianus HÖLZEL & OHM, 1991: 343 (odescr); HÖLZEL & OHM 1992 (list).
Dichochrysa mauriciana: HÖLZEL & OHM 1997 (comb, distr).

Only known from Mauritius

Dichochrysa militaris HÖLZEL et OHM, 2000

Dichochrysa militaris HÖLZEL & OHM, 2000 (odescr).

Only known from Grande Comore.

Dichochrysa nicolaina (NAVÁS, 1929)

Chrysopa nicolaina NAVÁS, 1929*a*: 361 (odescr).
Chrysopa atomalis NAVÁS, 1933*b* (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).
Chrysopa bourgeonina NAVÁS, 1936 (odescr); HÖLZEL & OHM 1991a (syn).
Chrysopa (Anisochrysa) bourgeonina (NAVÁS): TJEDER 1966 (redescr, distr).
Mallada nicolaninus (NAVÁS): HÖLZEL & DUELLI 1990 (distr); HÖLZEL & OHM 1991*a* (syn, distr), 1992 (distr).
Dichochrysa nicolaina (NAVÁS): HÖLZEL 1995 (comb, distr); OHM & HÖLZEL 1998 (distr).

In the subregion on Madagascar and Mayotte; spread over the African ontinent from the Western Cape Province to the Cape Verde Islands, in Eastern Africa to the Republic of Sudan, Somalia and Ethiopia (HÖLZEL *et al.* 1999), also in Southern Arabia (HÖLZEL 1995).

Dichochrysa raedarii HÖLZEL et OHM, 2000

Dichochrysa raedarii HÖLZEL & OHM, 2000 (odescr).

Known only from Grande Comore.

Dichochrysa setosa HÖLZEL et OHM, 1995

Mallada sp.: HÖLZEL & OHM 1992 (distr).
Dichochrysa setosa HÖLZEL & OHM, 1995: 113 (odescr).

Known only from Madagascar.

Dichochrysa sjoestedti (VAN DER WEELE, 1909)

Chrysopa sjoestedti VAN DER WEELE, 1909*b*: 19 (odescr).
Chrysopa (Anisochrysa) sjoestedti (Weele): TJEDER 1966 (redescr, syn, distr).
Mallada sjoestedti (Van derWeele): HÖLZEL & OHM 1991*a* (comb, syn, distr).
Dichochrysa sjoestedti (VAN DER WEELE): OHM & HÖLZEL 1998 (comb, distr).

On the Comoro islands Mayotte, Moheli and Grande Comore; on the African continent from South Africa (TJEDER 1966) to Senegal (HÖLZEL *et al.* 1994) and Ethiopia (HÖLZEL *et al.* 1999).

Glenochrysa insularis insularis HÖLZEL, 1991

Glenochrysa insularis HÖLZEL, 1991: 80 (descr); HÖLZEL & OHM 1992 (list).
Glenochrysa insularis insularis: HÖLZEL & OHM 2000 (redescr. ssp).

The subspecies is found only on Madagascar (see Fig. 6).

Glenochrysa insularis mayottensis HÖLZEL et OHM, 2000

Glenochrysa insularis: OHM & HÖLZEL 1998 (distr).
Glenochrysa insularis mayottensis HÖLZEL & OHM, 2000 (odescr ssp).

The subspecies is found only on Mayotte (see Fig. 6).

Glenochrysa insularis grancomorensis HÖLZEL et OHM, 2000

Glenochrysa insularis grancomorensis HÖLZEL & OHM, 2000 (odescr ssp).

The subspecies is found only on Grande Comore (see Fig. 6).

Mallada desjardinsi (NAVÁS, 1911)

Chrysopa desjardinsi NAVÁS, 1911: 267 (odescr); ESBEN-PETERSEN 1927 (list).
Chrysopa boninensis Okamoto, 1914: 62 (odescr); HÖLZEL & OHM 1992 (syn).
Chrysopa serrandi NAVÁS, 1921: 70 (odescr); HÖLZEL & OHM 1992 (syn).
Chrysopa rutila ESBEN-PETERSEN, 1927: 453 (odescr); TJEDER 1966 (syn).
Chrysopa flavostigma ESBEN-PETERSEN, 1927: 451 (odescr); HÖLZEL & OHM 1992 (syn).
Chrysopa inclinata NAVÁS, 1934: 58 (odescr); HÖLZEL & DUELLI 1990 (list); HÖLZEL & OHM 1992 (syn).

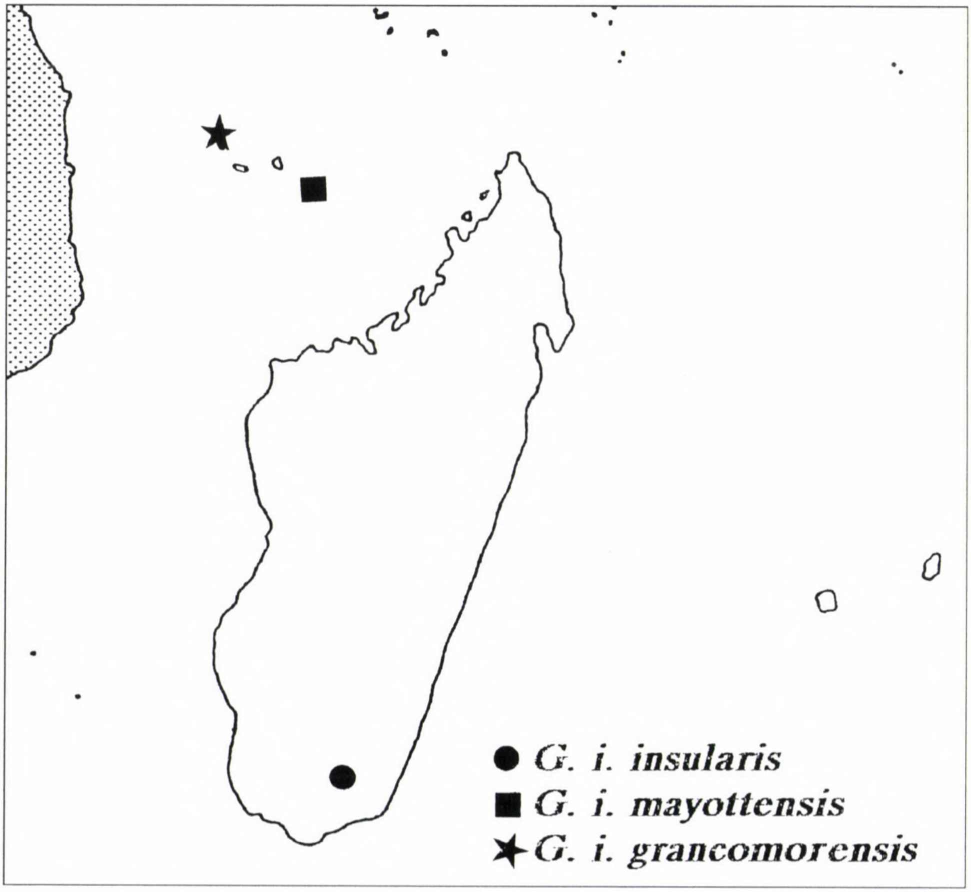


Fig. 6. The subspecies of *Glenochrysa insularis* HÖLZEL

Chrysopa (Anisochrysa) boninensis (Okamoto): TJEDER 1966 (redescr, syn, distr).
Mallada boninensis (Okamoto):; SÉMÉRIA & QUILICI 1986 (distr); BROOKS & BARNARD 1990 (comb); HÖLZEL & DUELLI 1990 (distr); HÖLZEL & OHM 1991*b* (distr).
Mallada desjardinsi (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (syn); OHM & HÖLZEL 1995 (distr), 1997 (distr), 1998 (distr).

Widespread and common in the subregion. Seychelles: In the central group on Mahé, Long Isl., Silhouette, Praslin and the coral reef Dennis Isl.; on the Amirantes (Coetivy) and on Aldabra. – On the Mascarene islands Rodriguez, Mauritius and La Réunion. On Madagascar and the Comoro islands Mayotte, Moheli and Grande Comore. In the continent from the Cape to Senegal and Cape Verde islands, in Eastern Africa to Somalia and Ethiopia (HÖLZEL *et al.* 1997, HÖLZEL *et al.* 1999). Eastward to islands in the Pacific Ocean (TJEDER 1966) (see Fig. 7).

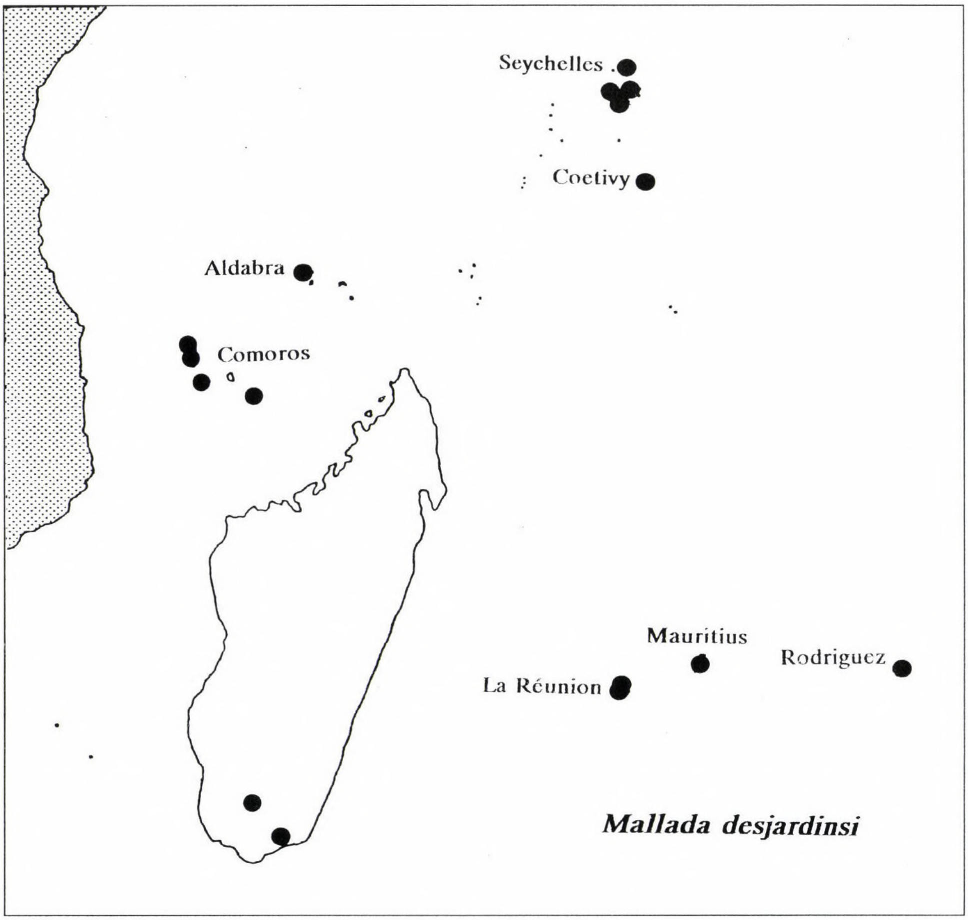


Fig. 7. *Mallada desjardinsi* (NAVÁS) in the Madagascan subregion

Plesiochrysa litorosa (NAVÁS, 1911)

Chrysopa litorosa NAVÁS, 1911: 6 (odescr); ESBEN-PETERSEN 1927 (redescr, syn, distr).
Chrysopa meriani NAVÁS, 1925 (odescr); ESBEN-PETERSEN 1927 (syn); HÖLZEL & OHM 1992 (syn).
Plesiochrysa litorosa (NAVÁS): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list); OHM & HÖLZEL 1995 (distr).

Known from the central Seychelles on Mahé, Long Isl., Silhouette, Praslin, Marie Anne and on the coral reef Dennis Isl.; in the Amirantes group the coral reef Poivre.

Plesiochrysa scotti (ESBEN-PETERSEN, 1927)

Chrysopa scotti ESBEN-PETERSEN, 1927: 449 (odescr).
Plesiochrysa scotti (ESBEN-PETERSEN): BROOKS & BARNARD 1990 (comb); HÖLZEL & OHM 1992 (list); OHM & HÖLZEL 1995 (distr).

Only known from the Seychelles islands Mahé, Praslin and La Digne.

Species undescribed

Chrysoperla sp. (♀ Grande Comore).
Dichochrysa ? sp. 1 (♂ Grande Comore).
Dichochrysa ? sp. 2 (♀ Moheli).
Dichochrysa ? sp. 3 (♀ La Réunion).
Dichochrysa ? sp. 4 (♀ La Réunion).
Dichochrysa ? sp. 5 (♀ La Réunion).

DISCUSSION

180 chrysopid species and subspecies are known from the entire Afrotropical region (HÖLZEL & OHM 2002). 54, i.e. 30% of them occur also or live exclusively in the Madagascan subregion. Among these 54 taxa 37 (68%) are endemics of the subregion (Table 1), so that ca 20% of the whole Afrotropical chrysopid fauna consists of endemics of the Madagascan subregion.

The fauna of the subregion is composed of different elements. The origin of the widespread species (Table 2) is exclusively the Afrotropical region, some distributed over the whole continent (e.g. *Borniochrysa squamosa*, Fig. 3); others are restricted to Eastern Africa (e.g. *Ankylopteryx pallidula*, Fig. 2). Among the endemics, only *Plesiochrysa scotti* and *P. litorosa*, from the Seychelles, belong to the *oceanica* group of the genus *Plesiochrysa*, which is spread from Pacific islands and Australia to Southern India.

Table 1. Distribution of Chrysopidae endemic in the Madagascan subregion (Up to now no endemic Chrysopidae were found on the islands of Anjouan and Rodriguez). GC: Grande Comore, MO: Moheli, MY: Mayotte, MA: Madagascar, RE: La Réunion, MS: Mauritius, SE: Central Seychelles

	GC	MO	MY	MA	RE	MS	SE
Plesiochrysa scotti	–	–	–	–	–	–	#
Plesiochrysa literosa	–	–	–	–	–	–	#[1]
Ankylopteryx alluaudi	–	–	–	#	–	–	#
Dichochrysa mauriciana	–	–	–	–	–	#	–
Chrysoperla insulata	–	–	–	–	#	–	–
Dichochrysa inopinata	–	–	–	–	#	–	–
Dichochrysa sp. 3		–	–	–	–	#	–[2]
Dichochrysa sp. 4		–	–	–	–	#	–[2]
Dichochrysa sp. 5		–	–	–	–	#	–[2]
Chrysoperla brevicollis	–	–	–	–	#	#	–
Dichochrysa duplicata mascarenica	–	–	–	–	#	#	–
Dichochrysa duplicata duplicata	–	–	–	#	–	–	–
Dichochrysa duplicata polyneura	#	#	#	–	–	–	–
Dichochrysa sp. 2	–	#	–	–	–	–	–[2]
Dichochrysa hospitalis	#	–	#	–	–	–	–
Dichochrysa militaris	#	–	–	–	–	–	–
Dichochrysa raedarii	#	–	–	–	–	–	–
Dichochrysa sp. 1	#	–	–	–	–	–	–[2]
Chrysoperla sp. 1	#	–	–	–	–	–	–[2]
Glenochrysa insularis grancomorensis	#	–	–	–	–	–	–
Glenochrysa insularis mayottensis	–	–	#	–	–	–	–
Glenochrysa insularis insularis	–	–	–	#	–	–	–
Ankylopteryx tanana	–	–	–	#	–	–	–
Parankylopteryx multipunctata	–	–	–	#	–	–	–
Chrysacanthia varicella	–	–	–	#	–	–	–
Italochrysa boueti	–	–	–	#	–	–	–
Italochrysa limbata	–	–	–	#	–	–	–
Italochrysa madagassa	–	–	–	#	–	–	–
Italochrysa nossibensis	–	–	–	#	–	–	–
Nesochrysa grandidieri	–	–	–	#	–	–	–
Nesochrysa marginata	–	–	–	#	–	–	–
Ceratochrysa disparilis	–	–	–	#	–	–	–
Chrysoperla decaryana	–	–	–	#	–	–	–

Table 1 (continued)

	GC	MO	MY	MA	RE	MS	SE
Dichochrysa decaryna	–	–	–	#	–	–	–
Dichochrysa incongrua	–	–	–	#	–	–	–
Dichochrysa setosa	–	–	–	#	–	–	–
Chrysemosa umbralis	#	#	#	#	#	#	#

[1]Also on the Seychelles coral reef group Amirantes.
[2]The species *Chrysoperla* sp. 1 and *Dichochrysa* sp. 1, 2, 3, 4 and 5 are available only as single females respective a very immature male. So they are not described hitherto.

Table 2. Distribution of Madagascan Chrysopidae not endemic in the subregion. SEY: Seychelles, MAR: Mascarene Islands, MAD: Madagascar, COM: Comoros, EA: Eastern Africa, AC: Wider spread on the African continent south of Sahara, PAZ: African continent and eastward to the Pacific Region

	SEY	MAR	MAD	COM	EA	AC	PAZ
Ankylopteryx pallidula	–	–	–	#	#	–	–
Italochrysa variegata	–	–	#	#	#	–	–
Chrysoperla volcanicola	–	–	–	#	#	–	–
Dichochrysa sjoestedti	–	–	–	#	#	#	–
Dichochrysa hamata	–	–	#	–	#	–	–
Dichochrysa luaboensis	–	–	#	–	#	–	–
Dichochrysa handschini	–	#	–	–	#	–	–
Brinckochrysa pulchella	–	–	#	–	#	#	–
Brinckochrysa stenoptera	–	–	#	–	#	#	–
Anapochrysa voeltzkowi	–	–	#	#	#	#	–
Dichochrysa nicolaina	–	–	#	#	#	#[1]	–
Borniochrysa squamosa	–	#	#	#	#	#	–
Ceratochrysa antica	–	#	#	#	#	#	–
Brinkochrysa lauta	#	#	#	#	#	–	–
Apertochrysa eurydera	#[2]	#	#	#	#	#	–
Mallada desjardinsi	#[2]	#	#	#	#	#	#
Chrysoperla congrua	–	#	#	#	#	#	#[1]

[1]Also in Southern Arabia
[2]Also on coral reefs of Amirantes and Albarda

The chrysopid fauna of the different archipelagos (Fig. 8)

Only 6 chrysopid species are found in the Seychelles. The two endemic *Plesiochrysa* species, *A. alluaudi* (restricted to the subregion), *Brinckochrysa lauta* (also living in Eastern Africa), and the widespread species *Apertochrysa eurydera* and *Mallada desjardinsi*. The endemic species occur at all altitudes and the two widespread species are found only in lower sites near the coast and on some of the atolls.

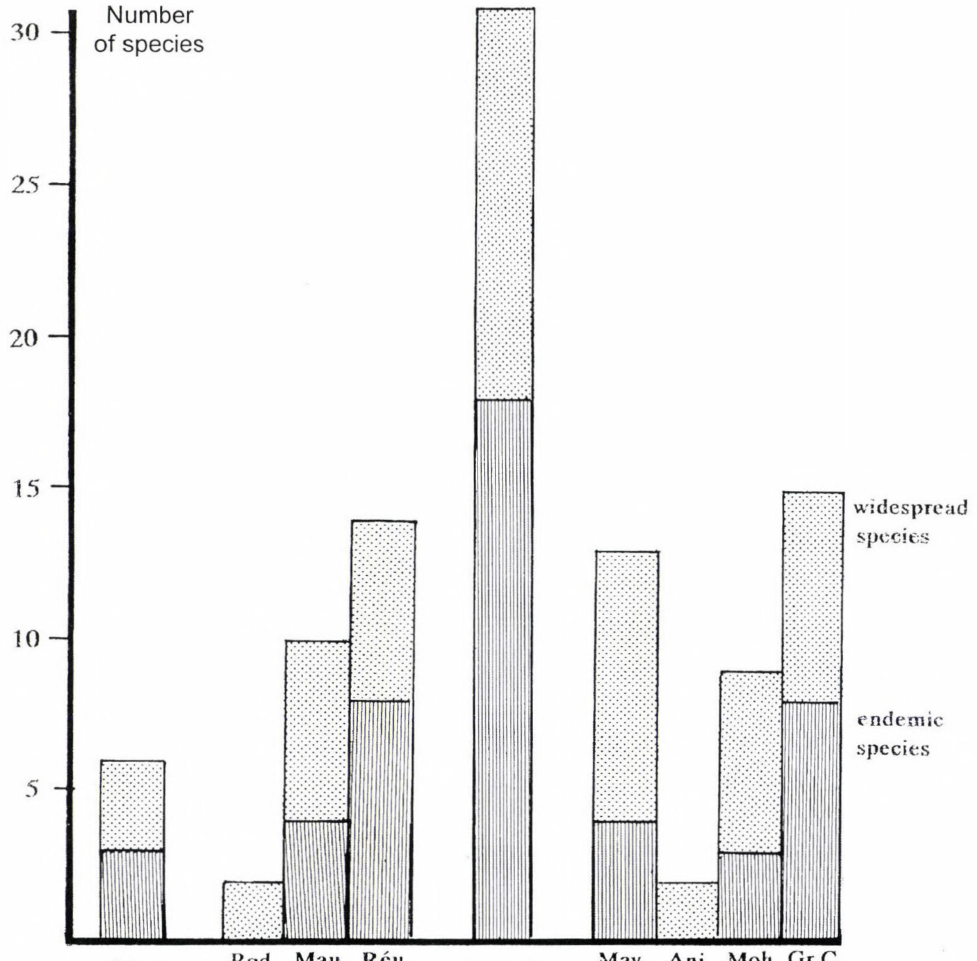


Fig. 8. The chrysopid fauna in the different archipelagos

In the Mascarene archipelago the small Eastern island of Rodriguez was visited in an unfavourable season and is poorly known. Only the two widespread species which occur also on some atolls were found.

Mauritius reaches an altitude of 828 metres, in higher parts bearing some remnants of indigenous forests. The lower parts are intensively cultivated. The island harbours 6 widespread species and 4 endemics, among them *Dichochrysa mauriciana* that is exclusive to this island. *Chrysoperla brevicollis* and *Dichochrysa duplicata mascarenica* are shared with La Réunion, *Chrysemosa umbralis* with all Madagascan archipelagos except the Seychelles (Fig. 4).

La Réunion, the highest island of the archipelago, reaches 2632 metres. Higher parts and the moist southeastern slopes bear a partly distorted indigenous forest. In higher sites extensive heather formations are found. Besides the 2 endemics shared with Mauritius, one shared with all archipelagos except the Seychelles, the island harbours the endemic *Chrysoperla insulata, Dichochrysa inopinata* and 3 undescribed, probably endemic species, all living mainly in higher or moist sites. The 6 species also living on the continent were found mainly in lower, cultivated aereas.

Madagascar is by far the richest and most diverse of all islands of the subregion. It harbours 31 chrysopids, including 18 endemic and 13 widespread species. Among 33 endemics of the whole subregion 16 are only known from this island.

The high percentage of Belonopterygini (with 45 species occuring in the entire Afrotropical region) in the fauna of this island is remarkable. Seven species of this tribe whose larvae probably live in the nests of ants or termites are endemic in Madagascar. The only other species of this tribe that is known from the subregion is *Italochrysa variegata*, which is widespread in eastern Africa. By contrast, only 7 Chrysopini, a much more numerous tribe (with about 100 species in the entire Afrotropical region), are endemic here. One reason for this impression of the Madagascan fauna may be the intensity of work done in the island and the history of research. Research emphasising Neuroptera did not occur, but in the available material in museum collections the larger, more conspicuously coloured Belonopterygini are overrepresented.

The Comoro archipelago harbours 12 widespread and 10 endemic species or subspecies. *C. umbralis* inhabits large parts of the subregion, while the other 9 occur only in this archipelago, 5 of them only occur on the largest and highest island of Grande Comore. *Glenochrysa insularis* has developed the subspecies *G. i. grancomorensis* and *G. i. mayottensis* in Grande Comore and Mayotte respectively.

Besides *Glenochrysa insularis* with two subspecies in the Comoros and *G. i. insularis* in Madagascar (Fig. 6), *Dichochrysa duplicata* is also represented in the

subregion with 3 subspecies: *D. d. mascarenica* on Mauritius and La Réunion, *D. d. duplicata* on Madagascar and *D. d. polyneura* on the Comoro islands Mayotte, Moheli and Grande Comore (Fig. 5).

Among the 17 widespread species living in the subregion (Table 2), 7 occur on the continent only in eastern Africa. Among the remaining 10 species living in wider parts of the continent are several common species of ecological (e.g. *Dichochrysa sjoestedti, Borniochrysa squamosa),* sometimes also agronomical importance (*Apertochrysa eurydera, Chrysoperla congrua Dichochrysa nicolaina, Ceratochrysa antica* and *Mallada desjardinsi*). In the higher islands La Réunion and Grande Comore they occur mainly or exclusively in lower, cultivated areas. Some of them may be introduced by man via agriculture or fruit cultivation.

Among the species also found on the continent, *Ankylopteryx pallidula, Chrysoperla volcanicola* and *Dichochrysa sjoestedti* reached only the Comoros, 7 species Madagascar and 7 also the Mascarenes or even the Seychelles, among them all species of possibly economical value. *Mallada desjardinsi* is the most widespread species, from Southern Africa and the Cape Verde Islands (see HÖLZEL *et al.* 1994, fig. 14) eastward to the Bonin Islands in the Pacific Ocean (see TJEDER 1966, fig. 1746) as well as in the Madagascan subregion (Fig. 7).

*

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WHAT IS THE REAL NAME OF THE ITALIAN ASCALAPHID?

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An endemic species of Ascalaphidae living exclusively in the Italian peninsula has been named for over a century *Libelloides italicus* FABRICIUS (1781). This is the case of a long-term, established, nomenclatorial situation which has apparently caused no problems. Unfortunately, FABRICIUS' type does not correspond to the Italian ascalaphid. Thus an old dispute has been re-opened and so the chronology concerning it are discussed.
In conclusion, *Ascalaphus italicus* FABRICIUS, 1781 is a junior synonym of *Libelloides coccajus* ([DENIS & SCHIFFERMÜLLER], 1775) (syn. n.) and a senior synonym of *Ascalaphus meridionalis* DE CHARPENTIER, 1825. There are two possible names for the Italian ascalaphid: *Libelloides latinus* (LEFEBVRE, 1842) (comb. n.), that is its valid name, and *Ascalaphus petagnae* COSTA, 1855 which is its junior synonym.

Key words : Ascalaphidae, Italy, nomenclature

INTRODUCTION

Both the authors have always paid particular attention to the chorological data deriving from ancient bibliographical sources, checking them with direct and indirect methods. This information allows a comparison between past and present geographic distributions evaluating any modifications in local fauna.

While looking at the problems involved in interpreting old references, LETARDI (1995) clearly demonstrated that there was considerable confusion in the nomenclature of the ascalaphids quoted in Italy, at least up to the last decades of the 19th century. Subsequently, on analysing the work of the Neapolitan entomologist ACHILLE COSTA, PANTALEONI (1999) found traces of past controversy.

In particular, it seemed that *Libelloides italicus* FABRICIUS (1781) was not, as had been believed for more than a century, the denomination of the Italian endemic species of Ascalaphidae (strictly confined to the peninsula) but a junior synonym of the Central European species *Libelloides coccajus* ([DENIS et SCHIFFERMÜLLER], 1775). The "case" was worth investigating.

DISTRIBUTION OF THE ITALIAN ASCALAPHID

In the Italian peninsula an endemic species of Ascalaphidae typically colonises the natural and semi-natural dry grasslands inside the hill vegetation belt (200–600 m) (ASPÖCK *et al.* 1980, PANTALEONI 1990*a*, 1990*b*, LETARDI 1998).

The geographical distribution of this taxon appears very defined. Even if listing only the material personally seen by the authors, unpublished or published (PANTALEONI 1986, 1988, 1990*a*, *c*, *d*, LETARDI 1991, 1998, PANTALEONI *et al.* 1994, BERNARDI IORI *et al.* 1995, LETARDI & PANTALEONI 1996, PANTALEONI & LETARDI 1998, LETARDI 2000), the species is reported in all the regions of the Italian peninsula and is limited to the north by the hills that face the Pianura Padana in Emilia-Romagna, and to the west by the hills of the province of Savona in Liguria.

Some bibliographic reports about collecting sites in the Alpine chain (LAZZARINI 1896, CASTELLANI 1958) are very dubious and almost certainly wrong (LETARDI 1995).

On checking the two main Turin collections known to us, those at the Regional Natural Science Museum (where all the historical entomological collections previously stored at the University are kept) and in the entomological section of the "Dipartimento di Valorizzazione e Protezione delle Risorse Agroforestali" (ex Istituto di Entomologia agraria) of the Agricultural Faculty, not one specimen of Italian ascalaphid from Piedmont was discovered.

THE FABRICIUS TYPE

FABRICIUS described *Ascalaphus italicus* in 1781, with the sentence "Habitat in Italia Dr. Allioni", basing this on one or more specimens sent to him by the Italian entomologist CARLO ALLIONI.

CARLO ALLIONI (1728–1803) was a physician, Professor of Botany at Turin University and Director of the Turin Museum, treasurer of the Royal Academy of Science. He also spent many years studying entomology, assembling a conspicuous insect collection (GLIOZZI 1960, POGGI & CONCI 1996). According to the little information we have, he only collected insects in Piedmont, perhaps only near Turin (PASSERIN D'ENTREVES 1983).

ZIMSEN (1964: p. 612, n. 68) stated the type of this taxon is in the collection "Kiel". This specimen is now in the Zoological Museum, University of Copenhagen, and thanks to Dr. N. P. KRISTENSEN, Professor of Systematic Entomology at the Zoological Museum, University of Copenhagen, we are able to obtain a photo (Fig. 1*b*). It is without doubt a *L. coccajus*.

As Dr. KRISTENSEN wrote to us, "the photographed specimen is the only one under that name in the Kiel collection drawer, and it bears the label 'italicus' written in what is believed to be Fabricius' own handwriting. It cannot be doubted, then, that the specimen in question at least corresponds to his concept (or memory) of that species".

According to TUXEN (1967) "Fabricius did not have the concept of type specimens that we use today". Therefore, it is possible, but no longer provable, that other examples were present in the ALLIONI's collection which was destroyed by fire (POGGI & CONCI 1996). Nevertheless, as did TUXEN (1967), ZIMSEN (1964) "realised that in the locality-collector reference FABRICIUS might give only the locality and collector (e. g. "in Italia Dr. Allioni"), or he might add: "Mus." and then a name (Mus. Dom. de Bosc; Mus. Dom. Banks; Mus. Dom. Lund; etc.). From this she inferred, though it is nowhere stated explicitly in his books, that in the latter case he had described the species on material in other people's collections, while in the first case the "type specimen" was to be found in his own collection. Her work, based on this axiom, showed this to be the case."

THE HISTORICAL "CASE"

Figures in PETAGNA (1786) [*sub Ascalaphus barbarus*] (fig. 1*d*) and in CIRILLO (1787–1792) [*sub Ascalaphus italicus*] (fig. 1*e*) are the first descriptions of the Italian ascalaphid. Once again PETAGNA (1792) first distinguished the Italian ascalaphid, as *Ascalaphus barbarus*, from the Central European taxon [*L. coccajus*], he named it *Ascalaphus italicus*. The works of the two Neapolitan authors have had neither a fair diffusion among scientists of that period nor an adequate recognition by them. Therefore the "case" started with the publication of "Horae Entomologicae" by DE CHARPENTIER (1825).

This author was able to distinguish the Italian endemic species from the Central European one with a masterly comparative description strengthened by the publication of two beautiful colour figures (Fig. 1*j* and 1*k*). The specimens of one of the two species came from Pisa (Tuscany, central Italy), the others from Spain. He gave the name "*italicus*" to the Italian specimens and attributed the new name "*meridionalis*" to the others, but he did not justify his choice by stating the geographic origin. He supplied a bibliography of authors who had distinguished "*utramque speciem pro una eadamque*", and asserted that he believed that all cited figures (SCHAEFFER 1763, 1766*a, b* [Fig. 1*a*], SULZER 1776, PANZER 1796 [Fig. 1*g*], DUMERIL 1823 [Fig. 1*f*]), with one exception (LATREILLE 1805 [Fig. 1*h*]), belonged to *Ascalaphus italicus* (*sensu* DE CHARPENTIER) due to the yellow spots on

the thorax, although the "*alarum figura seu ambitu*" was more similar to *Ascalaphus meridionalis*.

About fifteen years after, BURMEISTER (1839) rejected such a choice of names and considered *Asc. meridionalis* as synonymous of *Asc. italicus* and *Asc. italicus sensu* DE CHARPENTIER as synonymous of *Asc. lacteus* [now *Libelloides ottomanus* (GERMAR, 1817)]. It appears evident from the text that, according to the German author, the yellow spots on the thorax could not be considered characteristic, indeed he attributed to both the colour "*niger, thorace flavo-guttato*".

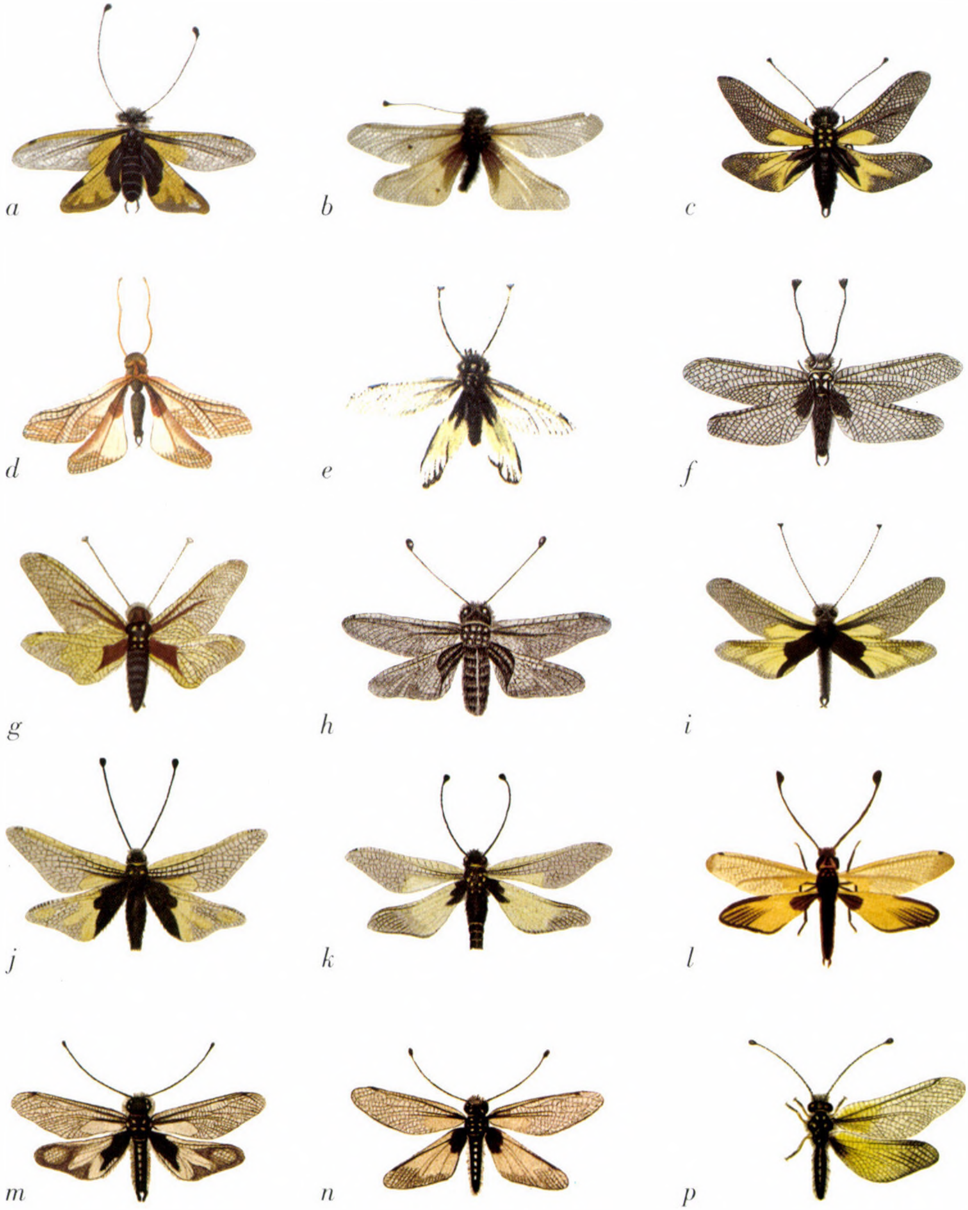
A few years later, LEFEBVRE (1842) joined in the debate with a single phrase loaded with consequences: "Je crois aussi que M. Burmeister ferait mieux de ne pas confondre the *Lacteus* de Brullè avec Mon *Latinus* (l'*Italicus* de Charp.)". Actually he found that the Italian ascalaphid was a different species from *Asc. lacteus* and, since it was still without a name, called it *Ascalaphus latinus*.

Immediately afterwards, RAMBUR (1842), who knew the work of LEFEBVRE (cfr. p. 341) and was in strong contrast with him on other issues (cfr. footnote page XIII), accepted the opinion of DE CHARPENTIER, but was evidently reluctant to make this resolution. In fact in the attached tables the figure of the Italian ascalaphid (Fig. 1*l*) appears with the new name of *Ascalaphus petagnae*. In the text, undoubtedly completed after the figures, Rambur disowned such a name ("La figure porte par erreur le nom de *Petagnæ*." cfr. p. 346) adopting instead *Asc. italicus*. He justified his choice "parce qu'il l'avait reçu d'Italie, où le *Meridionalis* ne paraît pas se truver." To this last species he attributed a distribution centred in southern France, not beyond the Pyrenees to the west and "ni s'avancer beaucoup en Italie" to the east. However, RAMBUR didn't blindly agree with the opinions of

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Fig. 1. – First illustrations. a = *Libelloides primus femina* [sic!] tab. L fig. II in SCHAEFFER, 1766 [editio 1791]; b = *Ascalaphus italicus* FABRICIUS, 1781 typus [photo KRISTENSEN]; c = *Ascalaphus italicus* tab. XXV fig. 4 in ROEMER, 1789 [= SULZER, 1776 ?]. The true Italian Ascalaphid: d = *Ascalaphus barbarus* fig. XXII in Petagna, 1786 [*editio nova cum XXXVIII iconibus ad naturam coloratis, Lipsiae, apud Ioannem Sommer, 1808*]; e = *Ascalaphus italicus* tab IX fig. 9 in CIRILLO, 1787–1792; f = *Ascalaphus barbarus* tab. 57 fig. 5 in DUMERIL, 1823. *Ascalaphus italicus* sensu antiquo: g = *Ascalaphus italicus* heft III n. 23 in PANZER, 1796; h = *Ascalaphus italicus* tab. XCVII (bis) fig. 3 in LATREILLE, 1805; i = *Ascalaphus italicus* heft 7 fig. 1 in LABRAM & IMHOFF, 1836. The debate: j = *Ascalaphus meridionalis* tab. II fig. 8 vs. k = *Ascalaphus italicus* tab. II fig. 9 in de CHARPENTIER, 1825; l = *Ascalaphus petagnae* [= *Ascalaphus italicus* in text] tab. 9 fig. 3 in RAMBUR, 1842; m = *Ascalaphus italicus v. leucocelius* tab. VII fig. 2 vs. n = *Ascalaphus petagnae* tab. VII fig. 4 in COSTA, 1855; p = *Ascalaphus italicus* tab. II *s.n.* in VAN DER WEELE, [1909]. [Source of illustrations: *a, c, f, g, h, i, j, k* Libr. Spinola in Regional Museum of Natural Science, Turin; *b* Zoological Museum, University of Copenhagen; *d* Libr. Zoological Institute, University of Rome 1; *e* Libr. Natural History Museum London; *l* Libr. M. M. Principi Bologna; *m, n* Libr. Istituto di Entomologia "G. Grandi" Bologna; *p* Libr. A. PANTALEONI Sassari.]


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DE CHARPENTIER. In fact the *Asc. ictericus* described by the latter finds a place in the tables but is replaced in the text by *Asc. barbarus* sensu LATREILLE. Besides, in the preface (cfr. note to page IV), he accuses him, together with Burmeister, of displaying "une préférence fort peu légitime dans l'adoption de noms de genres et d'espèces, qui sont loin d'avoir la priorité".

Also WALKER (1853) adopted DE CHARPENTIER's opinion, citing, moreover, for the first time *Asc. meridionalis* of Italy.

Besides the figures of the two species (Fig. 1*m* and 1*n*), COSTA (1855: p. 7–8) published a long report on the denomination of the Italian Ascalaphid. He contested DE CHARPENTIER because he took it upon himself to give great importance to the presence or absence of yellow spots on the thorax, rather than to the shape and the outline of the wing. Moreover, he contested RAMBUR's hypothesis that only one of the two species lived in Italy, having picked up both in southern Italy. Finally, he assigned to the Italian Ascalaphid the name given to him first by RAMBUR, *Asc. petagnae*, "sia per non accrescer nomi, sia perché pare che il Petagna fosse stato il primo a darci la figura di questa specie."

HAGEN (1860) intervened five years later. He published a critical review of COSTA's volume and a "Synopsis synonymica" of the genus *Ascalaphus* in which he stated that the Italian Ascalaphid was the *Asc. italicus sensu* DE CHARPENTIER. Concerning the report published by COSTA, he wrote (cfr. p. 45): "Costa giebt eine längere Erklärung, warum er den Namen A. Petagnae vorzieht, die mir zum Theil unverständlich geblieben ist."

VAN DER WEELE ([1909]) closed the debate by agreeing with HAGEN's opinion, also publishing a beautiful figure of the Italian Ascalaphid (fig. 1*p*).

USE OF THE NAME ASCALAPHUS ITALICUS

Ascalaphus italicus was described by FABRICIUS in 1781. It is extremely difficult to decipher the interpretation of the species of the Danish author from the bibliographical data alone. In the following works (FABRICIUS 1787, 1793) he considered his *italicus* synonymous (junior) of *Myrmeleon longicorne* LINNAEUS, 1764, and at the same time compared it to a figure of SULZER (1776: tav. 25, fig. 4)* [*sub Myrmeleon barbarus*] that in 1781 was referred to as *Asc. barbarus*.

* We have not been able to find this figure. According to HAGEN (1860), who saw it [no asterisks before the citation], and VAN DER WEELE ([1909]) it represents *Libelloides coccajus*. It was probably republished in ROEMER (1789) [*cfr.* " Prefatio " (p. V-VIII), publisher's coincidence (STEINER), table (XXV) and figure (4)] (fig. 1*c*).

The name *italicus* was used up to at least 1825, date of publication of DE CHARPENTIER's "Horae Entomologicae", for at least three species: the true Italian Ascalaphid by CIRILLO (1787–1792) and perhaps by ROSSI (1790); the actual *Libelloides longicornis* (LINNAEUS, 1764) by OLIVIER (1790) [*teste* VAN DER WEELE ([1909])] and by DUMERIL (1823); *Libelloides coccajus* certainly by ROEMER (1789) (fig. 1*c*), DE VILLERS (1789), PETAGNA (1792), PANZER (1796)** and LATREILLE (1805, 1807) besides, according to VAN DER WEELE ([1909]), TROST (1801) and LEACH (1815).

Between 1825 and 1860 the majority of entomologists attributed the name *italicus* to the taxon currently named *L. coccajus*, with the exception of the authors involved in the "case". See for instance ANGELINI (1827), LABRAM and IMHOFF (1836) (Fig. 1*i*), DESMAREST (1845), and, according to VAN DER WEELE ([1909]), also PERLEB (1826), HERRICH-SCHAEFFER (1840) and CUVIER (1846). WALKER (1853), when citing *Asc. italicus* from southern France, was perhaps indicating the Provencal population of *Libelloides ottomanus*. Otherwise only DISCONZI (1857), in an unimportant local paper, used "*italicus*" for *L. longicornis* [*teste* DISCONZI, 1865: fig. 118].

After 1860, date of publication of "Synopsis der Ascalaphen Europas" by HAGEN, and moreover 1909, with the publication of VAN DER WEELE's monograph, the name *italicus* was exclusively attributed to the Italian Ascalaphid.

CONCLUSION

It appears evident that first DE CHARPENTIER (1825), though not explicitly, then RAMBUR (1842), expressly, attributed the name *italicus* to the Italian Ascalaphid as a consequence of the coincidence between the name and the geographical distribution of the species. In making this decision neither the descriptions by FABRICIUS, to tell the truth uninterpretable, nor the usage prevailing at the time were taken into consideration. Some authors disagreed with this formulation (BURMEISTER 1839, COSTA 1855), but the descriptive strength of the name *italicus* was too attractive not to prevail over a law of priority which was not codified in the time.

** This bibliographical reference is extremely problematic. The date of publication according to VAN DER WEELE ([1909]) is 1813, ILLIGER (1807) reported the same figure as *barbarus*, in DE CHARPENTIER (1825) we can read "*Asc. barbarus in tabula: Asc. italicus in textu*". Evidently several reprints [editions] with subsequent corrections were published. The copy, we have been able to examine (in the Spinola Library, the Regional Museum of Natural Sciences, Turin) quotes *italicus* only.

The examination of the type according to ZIMSEN (1964) proves who was right. The few doubts that remain about this designation certainly are not enough to consider it invalid, considering that the data in our possession, about the origin of the material sent by ALLIONI to FABRICIUS, enables us to confirm that the type locality of *Ascalaphus italicus* is Piedmont (under Article 76 and Recommendation 76A of the fourth edition of International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1999) [from now on simply ICZN]), thereby making it inevitable that the type of *italicus* does not correspond to the Italian Ascalaphid.

Ascalaphus italicus FABRICIUS, 1781 is therefore a junior synonym of *Libelloides coccajus* ([DENIS et SCHIFFERMÜLLER], 1775), and, as already pointed out by BURMEISTER (1839) and COSTA (1855), a senior synonym of *Ascalaphus meridionalis* DE CHARPENTIER, 1825.

Ascalaphus latinus LEFEBVRE, 1842 is an available name under the ICZN Article 12.2 and is the valid name of the Italian Ascalaphid. Also available, but a junior synonym of the first one is *Ascalaphus petagnae* COSTA, 1855 (originally written with a capital letter, corrected under the ICZN Articles 28, 32.4, and 32.5.2.5). To define the authorship of this name we have applied the ICZN Articles 11.5 (as in PANTALEONI 1999).

There is not doubt that in the case of *Ascalaphus italicus* [as *Libelloides italicus*] the prevailing usage is as the name of the Italian Ascalaphid. According to the General recommendations of ICZN (Appendix B, Stability of nomenclatures) this use "should" be preserved and this is possible only through the application of the ICZN Article 75.6 "Conservation of prevailing usage by a neotype" according to which an author "should maintain prevailing usage and request the Commission to set aside under its plenary power the existing name-bearing type and designate a neotype". The discretion left to the authors is not clear however: they "should", not "must", preserve the prevailing use, especially in the presence of a threat to the stability and the universality of the names.

We are not sure whether or not to follow this recommendation. A useful and pragmatic decision would be in fact to maintain the name *italicus* for the Italian Ascalaphid. It would be necessary, however, to create a neotype based on material deriving generically from the Italian peninsula and not from Piedmont, modifying the same type locality of the species. Moreover it would be necessary to invalidate a FABRICIUS type of 1781, taxonomically perfectly identifiable. Finally we should bring to a close this old fascinating dispute with the perpetration of a "true historical falsehood". All this appears to be out of proportion as the only aim is to avoid the two nomenclatorial changes listed below, that are not, however, going to cause

any particular problems. Simply, the Italian Ascalaphid will affectedly be called *latinus* rather than possessing the fine name *italicus*.

Ascalaphus italicus FABRICIUS, 1781 = *Libelloides coccajus* ([DENIS & SCHIFFERMÜLLER], 1775) (syn. n.)

Ascalaphus italicus sensu DE CHARPENTIER, 1825 *nec* FABRICIUS, 1781 = *Libelloides latinus* (LEFEBVRE, 1842) (comb. n.) = *Ascalaphus petagnae* COSTA, 1855

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RECENT ADDITIONS TO THE GREEN LACEWING FAUNA OF ROMANIA (NEUROPTERA: CHRYSOPIDAE)

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The fauna of Romania included 25 species of green lacewings. Eight more species were recently established. The localities where they were found are given.

Key words: Neuroptera, Chrysopidae, Romania, distribution

INTRODUCTION

Thirty years ago, KIS *et al.* (1970) published a monograph of the Neuropteran fauna of Romania, under the authority of the Academy of Sciences of Romania. Then, it constituted a major step forward in the knowledge of lacewings and it is still a basic tool to entomologists with an interest in neuropterology. This study included 24 species of Chrysopidae. Ten years later, the fauna of Europe compiled by ASPÖCK *et al.* (1980) listed the same green lacewings in Romania. However, the authors only added *Anisochrysa prasina* (BURMEISTER, 1839) – now belonging to the genus *Dichochrysa* YANG, 1991 – which was considered in the previous work as a synonym of *Chrysopa (Anisochrysa) ventralis* CURTIS, 1834, but they did not discriminate the two species in the distribution maps.

Since 1985, the Plant Protection Research Institute (ICPP) of Bucharest oversees a programme for development of IPM in crop cultivations. A light-trapping survey of beneficial insects was undertaken in several sites across the country providing data on insect predators including chrysopids. In addition, some other specimens of green lacewing were collected in various other localities by several colleagues to whom we wish to express our grateful thanks for their participation in this survey.

Thus, eight green lacewing species were recorded as new to Romania (PAULIAN 1996, PAULIAN *et al.* 1996, PAULIAN & CANARD 2000, PAULIAN *et al.* 2001). The present contribution aims to regroup the above-mentioned results and to indicate the localities (Fig. 1) where newly recorded green lacewings were found, as an update of our knowledge of the chrysopid distribution.

COLLECTION SITES AND RECENTLY IDENTIFIED SPECIES

The specimens mentioned in this study were collected at or in the near neighbourhood of 17 locations which are from North to South and from West to East (Fig. 1) (collecton sites for each species are given below in brackets):

1 – Rodna	7 – Beiuş	13 – Bucureşti
2 – Beclean	8 – Crasna	14 – Troianu
3 – Groşi	9 – Tîrnăveni	15 – Oltenitsa
4 – Scobîltseni	10 – Arad	16 – Mitreni
5 – Oradea	11 – Sinaia	17 – Dabuleni
6 – Huedin	12 – Uzlina	

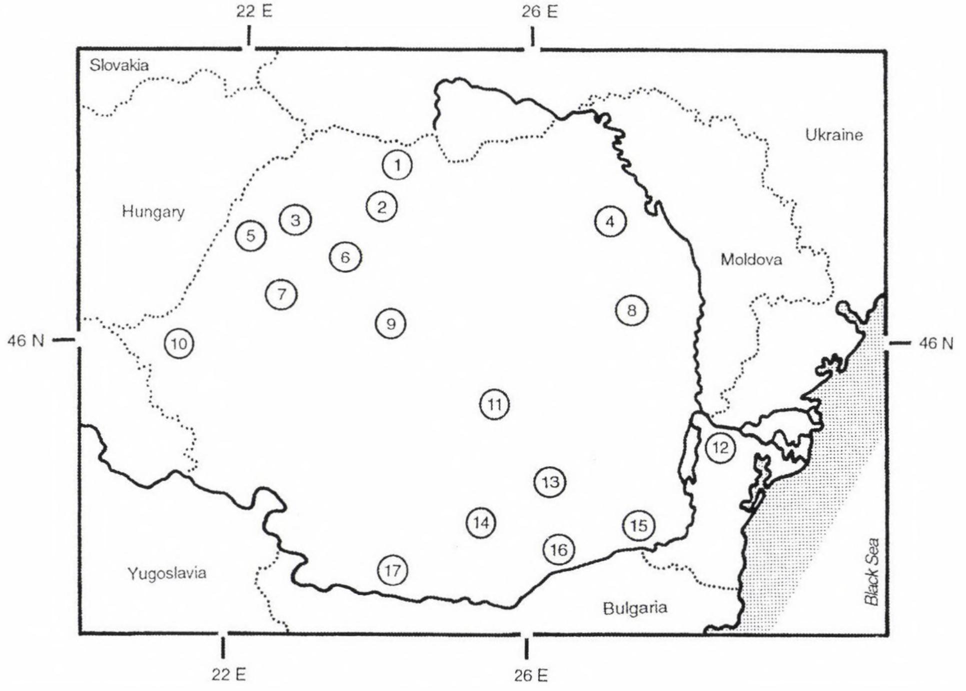


Fig. 1. Collection sites of the green lacewings recently recorded in Romania (for explanation see text)

Chrysoperla spp. The "common green lacewing" auctorum occurs in western Europe as a complex of probably five sibling species (BROOKS 2000). In the Romanian biotopes studied, we found three species (PAULIAN *et al.* 1996):

– a majority of *Chrysoperla kolthoffi* (NAVÁS, 1927) this taxon being here understood sensu LERAUT (1991) in absence of further information concerning its actual status; very common [1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17], probably everywhere;

– a smaller number of *Chrysoperla lucasina* (LACROIX, 1912) whose identity is now agreed (HENRY *et al.* 1996); common [1, 6, 7, 11, 12, 13, 14, 15, 16, 17];

– and more rarely the "true" *Chrysoperla carnea* (STEPHENS, 1836) sensu stricto [4, 6, 7, 9, 11, 13, 17].

Among *Chrysoperla* with claws having a subtriangular enlargement, we caught a specimen of *Chrysoperla renoni* (LACROIX, 1933) in the Danube delta [12]. This rare species was recently collected in northwestern Hungary, also in a wet habitat (SZIRÁKI 1998).

Dichochrysa prasina (BURMEISTER, 1839) occurred in many collections of green lacewings. On the contrary, *D. ventralis* (CURTIS, 1834) sensu stricto was uncommon, only identified in montane habitats of the Transylvanian district [11]. Consequently, all references from KIS's monograph need to be reviewed to ascertain the actual distibutions of these two species. *Dichochrysa prasina* is considered eurytopic whilst *D. ventralis* is more dependent on woodlands (PLANT 1994) or localised in higher altitude.

Dichochrysa abdominalis (BRAUER, 1856) was recently reinstated as a bona fide species by HÖLZEL (1998) although it is morphologically close to *D. prasina.* It is poorly known, probably rare, and seems localised in montane habitats. It was captured in montane habitats of the Transylvanian district [11].

Chrysopa dasyptera MCLACHLAN, 1872 is a small Euro-Siberian species collected in the vicinity of Bucharest [13] and in the Transylvanian Alps [11]. It was recently recorded from Poland (DOBOSZ 1999). Its occurrence in Hungary previously reported by SZABÓ & SZENTKIRÁLYI (1981) however remains dubious (SZIRÁKI pers. comm.).

Chrysopa dubitans MCLACHLAN, 1887 is a eurytopic species, widely distributed in the Palaearctic Region, from Spain where its occurrence remains dubious (MONSERRAT & MÁRIN 1994), Greece and Anatolia, up to Mongolia and China; it was also found in Algeria (ASPÖCK & HÖLZEL 1996). Rare, only found in the montane habitats of the Transylvanian district [11], light trapped in an open forest habitat, at 810 m of altitude.

Nineta inpunctata (Reuter, 1894) was collected in the mountains [11]. It has a Euro-Siberian distribution from West and North Europe to Ukraine. This lacewing was everywhere rarely encountered (CANARD *et al.* 1998).

Cunctochrysa baetica (HÖLZEL, 1972) is a holomediterranean species (ASPÖCK *et al.* 1980). Until recently, it has been collected in Romania only in the southern part of the Danubian Plain [15].

*

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The distribution of Hungarian molluscs

The catalogue of the Mollusca Collection of the Hungarian Natural History Museum

Z. Fehér and A. Gubányi

Authors aimed to continue the traditions of Hungarian faunal mapping set by Pintér and co-workers in 1979, and to create a computer programme and a database, that are able to collect and manage data both from the literature and collections and able to create distribution maps. Due to this "living" data system, where the integration of new data is permanently done and the errors are continuously corrected, the results are published in electronic format in English and Hungarian. The CD contains the catalogue in pdf format (the reader programme Adobe Acrobat Reader 4.0 also present). As the first step, this CD contains the checklist of the Hungarian molluscs and their distribution data based on the Mollusca Collection of the Hungarian Natural History Museum. Distribution of the 220 gastropod and 24 bivalve species in the collection are illustrated in 10×10 km UTM grid maps, and all of their sampling sites are listed by UTM grids.

The checklist follows the nomenclature of the CLECOM (Checklist of the European Continental Mollusca) project. With all those speciess that are known under a different synonym name in Hungary, or occur in Hungary but not mentioned in the CLECOM list, or are missing from the HNHM collection, or that are incorrectly indicated in Hungary, or their taxonomic position is judged by a competent Hungarian malacologist in another way then given in CLECOM, authors deal with in the Appendix. A glossary of the frequently used common names and geographical terms helps the use of the locality list. This issue will hopefully be followed by others containing literature data and data of other Hungarian mollusc collections, and the series will become a useful tool for malacologists dealing with zoogeography, ecology and nature conservation.

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ZOOGEOGRAPHICAL ANALYSIS OF NEUROPTERA IN BULGARIA

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The Bulgarian species of Neuroptera have been analysed according to origin, not on the basis of chorology. In Bulgaria, the more cold-loving of the Siberian elements inhabit the mountains only (*Sympherobius fuscescens*, *Micromus paganus*) and some ubiquists from the same category occur in the whole country (*Chrysopa perla*, *Myrmeleon formicarius*). Most of the Siberian–Mediterranean species have a broad ecological plasticity (*Coniopteryx pygmaea*, *Chrysopa formosa*). Only species with a typical Holarctic distribution in North America, but not Siberian and Holomediterranean elements that are probably casually introduced in the Nearctic, are interpreted as Siberian–Nearctic. The Central European and the Central European–Mediterranean species are rare components in the Bulgarian fauna. Holomediterranean elements are about twice as numerous as the Pontomediterranean ones. The expansive Holomediterranean species prevail considerably over the stationary ones. Among the Pontomediterranean elements both groups are equally represented in the fauna of Bulgaria. They have a Balkan (*Dilar turcicus*, *Nedroledon anatolicus*) or an Anatolian (*Isoscelipteron fulvum*, *Hemerobius zernyi*) origin. The species of southern origin (the Mediterranean elements) comprise 52% of the Bulgarian fauna of Neuroptera and predominate slightly over the species of northern origin (originated from the Central European and from the Siberian centres).

Key words: Neuroptera, Bulgaria, zoogeography, arboreal, oreotundral, eremial

INTRODUCTION

Bulgaria belongs entirely to the Eurosiberian Zoogeographical Subregion, but its southern border coincides in some places with the border of the Mediterranean Zoogeographical Subregion (Fig. 1). Thus, there is a small zone, inhabited by a typical stationary Mediterranean fauna (but except for the most typical Mediterranean vegetation) and of a wider transitional zone, inhabited by a slightly expansive Mediterranean or the so called Submediterranean fauna.

The Bulgarian species of Neuroptera have been analysed in this review according to origin, not on the basis of chorology. On the one hand, this has been done in order to avoid the gaps caused by insufficient exploration of some areas in their ranges, as for instance European and especially Asiatic Russia notwithstanding the intensive studies during the last 15 years. On the other hand, chorological data take no account of the influence of anthropogenic factor in habitat changes

and passive transport of species, such as deforestation or accidental introduction of European species to America.

ZOOGEOGRAPHICAL CATEGORIES

The zoogeographical categories proposed by DE LATTIN (1967), ASPÖCK, ASPÖCK & RAUSCH (1977), ASPÖCK, ASPÖCK & HÖLZEL (1980) and MALICKY *et al.* (1983) were used in the determination of origin. All 113 species occurring in Bulgaria originated in the Holarctic Region including those whose present ranges extend across the boundaries of the latter. All three large ecological-zoogeographical complexes (biochores or biomes) of the Holarctic are represented in the Bulgarian fauna of Neuroptera, but with varying proportions. The eremial fauna and the oreotundral fauna have one representative each in the country and all the other species are part of the arboreal fauna.

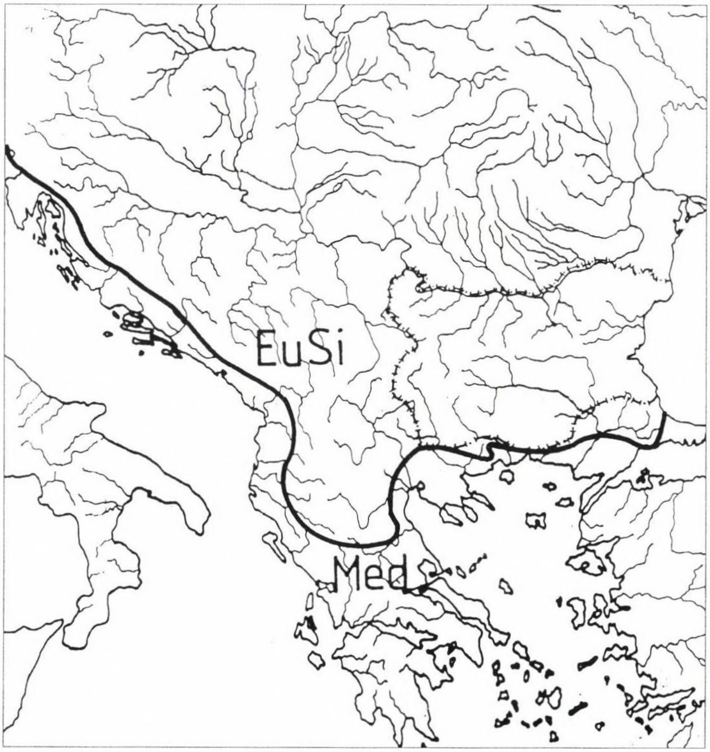


Fig. 1. Bulgaria (dashed line) and the border between the Eurosiberian (EuSi) and the Mediterranean (Med) zoogeographical subregions (solid line) on the Balkan Peninsula

Non-arboreal fauna

The only eremial species is the Bulgarian coniopterygid of the genus *Hemisemidalis* MEINANDER (Fig. 2), known by a unique unidentifiable female from Southwest Bulgaria (POPOV 1986). It is one of the few animal species occupying a borderline position between the arboreal fauna and the eremial fauna according to their present ranges. They inhabit both desert and semidesert territories in the Southern Palearctic and some arid and hot habitats in the Mediterranean Subregion.

The oreotundral fauna is also represented by a unique species – *Wesmaelius malladai* (NAVÁS). It can be put together (with some reservation) with the taxa with oreotundral, i.e. arctoalpine distribution, as well as with the oreal taxa on the basis of their origin. Concerning its range, *W. malladai* corresponds to the species

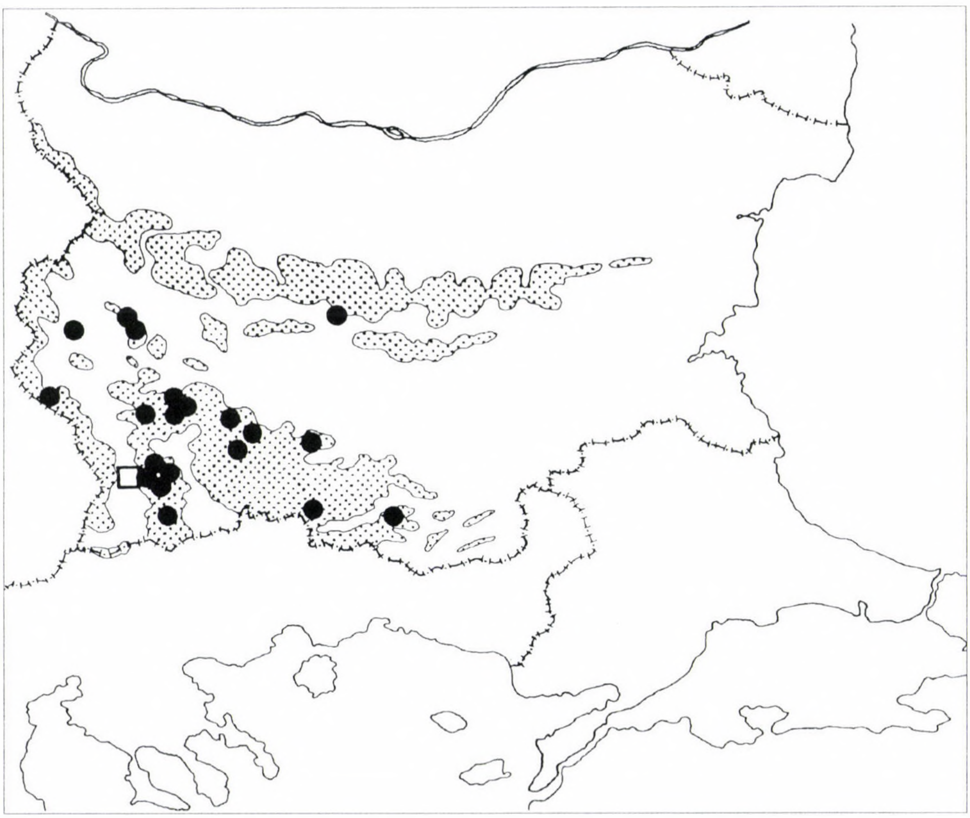


Fig. 2. Distribution of the eremial species *Hemisemidalis* sp. (□) and the oreotundral species *Wesmaelius malladai* (●) in Bulgaria. Areas above 1000 m altitude are shaded

with arctoalpine disjunction. The uncertainty arises from the fact that in Bulgaria (Fig. 2) it is typical for the coniferous belt with only a small part of its populations occurring above the timberline (POPOV 1997). Hence the conclusion that this hemerobiid probably occupies an intermediate position between the oreotundral arctoalpine and the arboreal boreomontane species (both terms confused and incorrectly united as "boreoalpine" in the past and sometimes also nowadays).

Siberian and Central European fauna

The remaining 98% of the Bulgarian species are arboreal. Their classification according to zoogeographical categories on the basis of origin is given on Table 1.

Part of the Siberian faunal elements consists of more cold-loving Neuroptera which inhabit only the mountains in Bulgaria, *e.g. Sympherobius fuscescens* (WALLENGREN), *Hemerobius pini* STEPHENS (Fig. 3). Others are ubiquists and occur in the whole country, e.g. *Chrysopa perla* (LINNAEUS), *Myrmeleon formicarius* LINNAEUS. The Siberian fauna has penetrated into the Balkan Peninsula in two directions: along the Dinaric Alps (southward and eastward) and along the Carpathians (southward). The expansive Siberian elements are often incorrectly named "Eurosiberian faunal elements". There are no such elements but only species with Eurosiberian distribution.

Most of the Siberian-Mediterranean species have a broad ecological plasticity and are widely spread in Bulgaria (*Coniopteryx pygmaea* ENDERLEIN, *Chrysopa formosa* BRAUER).

Table 1. Zoogeographical categories of Neuroptera in Bulgaria according to their origin

Categories	Species	%
Oreal	1	1
Siberian	22	19
Siberian–Mediterranean	10	9
Siberian–Nearctic	8	7
Central European	8	7
Central European–Mediterranean	5	4
Holomediterranean	38	34
Pontomediterranean	20	18
Eremial	1	1
Total	113	100

The species with Holarctic distribution are polycentric. They have an initial centre of dispersal in the Siberian Subregion (and a centre of development in the Manchurian Subregion) and an additional centre of dispersal in the Nearctic. Therefore, on the analogy of the Siberian-Mediterranean and the Central European–Mediterranean species, I propose for them the term Siberian–Nearctic. Only species with a typical Holarctic distribution in North America have been interpreted here as Siberian–Nearctic. Such are for instance the mountain species in Bulgaria *Helicoconis lutea* (WALLENGREN) and *Coniopteryx tineiformis* CURTIS as well as *Hemerobius humulinus* LINNAEUS, distributed mostly in the lowlands. Six Siberian and Holomediterranean elements have not been interpreted as Holarctic. Most likely they are casually introduced in the Nearctic, *e.g. Wesmaelius subnebulosus* (STEPHENS), *Psectra diptera* (BURMEISTER) and both *Conwentzia* ENDERLEIN.

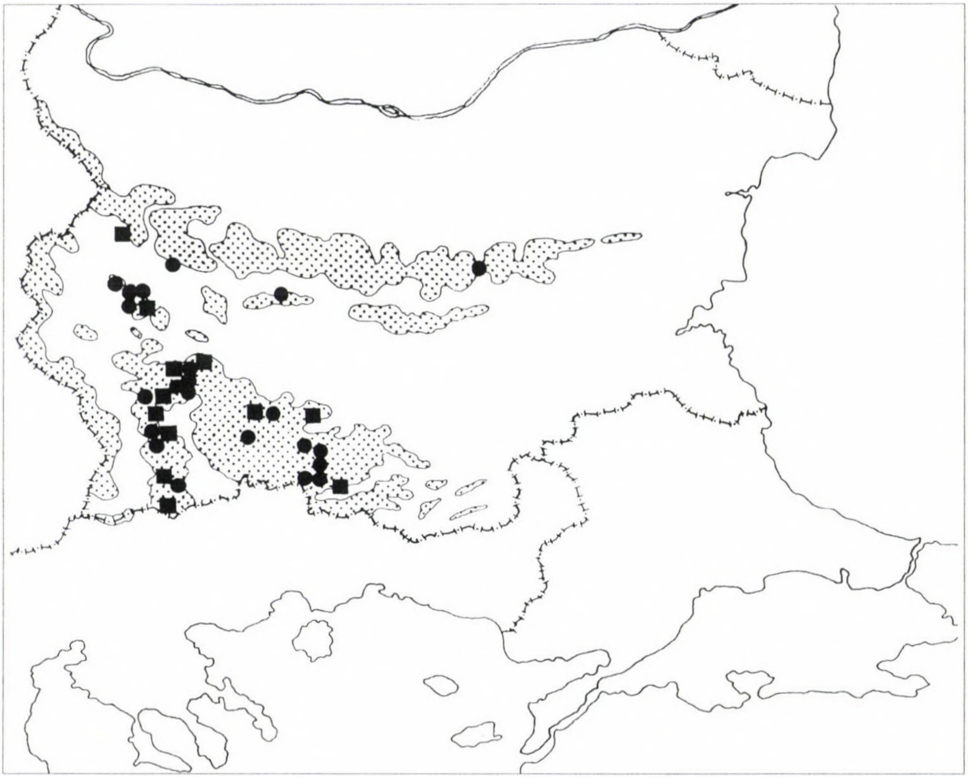


Fig. 3. Distribution of cold-stenothermic Siberian elements in Bulgaria: ● = *Hemerobius pini*, ■ = *Sympherobius fuscescens*. Areas above 1000 m altitude are shaded

The Central European species, e.g. *Hemerobius schedli* HÖLZEL, *Wesmaelius fassnidgei* (KILLINGTON), and the Central European–Mediterranean species, e.g. *Nothochrysa capitata* (FABRICIUS), *Euroleon nostras* (FOURCROY), are rare components in the Bulgarian fauna. Not one of them is among the first 45 most abundant species in Bulgaria. The category "Central European faunal elements" is often erroneously used in the faunistic and zoogeographical literature for the expansive Holomediterranean species. Another term, "European elements", is also used for the same purpose, but such a group exists actually only as a chorological category and not as a group of faunal elements.

Mediterranean fauna

Nearly all the Mediterranean species in the Bulgarian fauna originated from the northern part of the Mediterranean Subregion. The Holomediterranean elements are about twice as numerous as the Pontomediterranean ones (Table 1).

The expansive (according to their chorology) Holomediterranean species prevail considerably over the stationary ones (Table 2). Their postglacial ranges have been extended northwards, *e.g. Coniopteryx borealis* TJEDER, *Osmylus fulvicephalus* (SCOPOLI), *Wesmaelius ravus* (WITHYCOMBE), *Dichochrysa flavifrons* (BRAUER), or eastwards, e.g. *Mantispa aphavexelte* ASPÖCK et ASPÖCK, *Chrysopa viridana* SCHNEIDER, *Myrmecaelurus trigrammus* (PALLAS). Few species have been dispersed in both directions, *e.g. Chrysopa nigricostata* BRAUER, *Acanthaclisis occitanica* (VILLERS).

Among the Pontomediterranean elements both groups (stationary and expansive species) are equally represented in the fauna of Bulgaria (Table 2). Their dispersal has been also directed northwards (*Chrysopa dorsalis* BURMEISTER, *Chrysopa commata* KIS et ÚJHELYI), eastwards, e.g. *Creoleon plumbeus* (OLIVIER), or in both directions, e.g. *Libelloides macaronius* (SCOPOLI). The expansion of some species westwards has reached the Adriatomediterranean secondary centre, e.g. *Dichochrysa clathrata* (SCHNEIDER), *Nicarinus poecilopterus* (STEIN), *Deleproc-*

Table 2. Mediterranean categories of Neuroptera in Bulgaria

Zoogeographical categories	Species	% of all Mediterranean species	% of all species
Expansive Holomediterranean	24	42	21
Stationary Holomediterranean	14	24	12
Expansive Pontomediterranean	10	17	9
Stationary Pontomediterranean	10	17	9
Total	58	100	51

tophylla australis (FABRICIUS). The Pontomediterranean elements have a Balkan origin (*Dilar turcicus* HAGEN, *Nedroledon anatolicus* NAVÁS – Fig. 4), or an Anatolian origin (*Hemerobius zernyi* ESBEN-PETERSEN, *Isoscelipteron fulvum* COSTA – Fig. 5).

The strictly stationary Holomediterranean and Pontomediterranean elements inhabit only the warmest and driest arid habitats in Bulgaria, e.g. *Coniopteryx loipetsederi* ASPÖCK, *Helicoconis aptera* MESSNER, *Isoscelipteron fulvum* COSTA, *Hemerobius zernyi* ESBEN-PETERSEN, *Dichochrysa zelleri* (SCHNEIDER), *Myrmeleon noacki* OHM, *Nedroledon anatolicus* NAVÁS (Fig. 6). They have penetrated into Bulgaria along three routes: along the valley of Struma River, along the Arda River Valley in East Rhodopes and along the southern part of the Bulgarian Black Sea Coast. Other stationary species occur as well in the Submediterranean territories (with less strong Mediterranean influence), i.e. the Thracian Lowland and the Subbalkan kettles in South Bulgaria, the northern part of the Bulgarian Black Sea

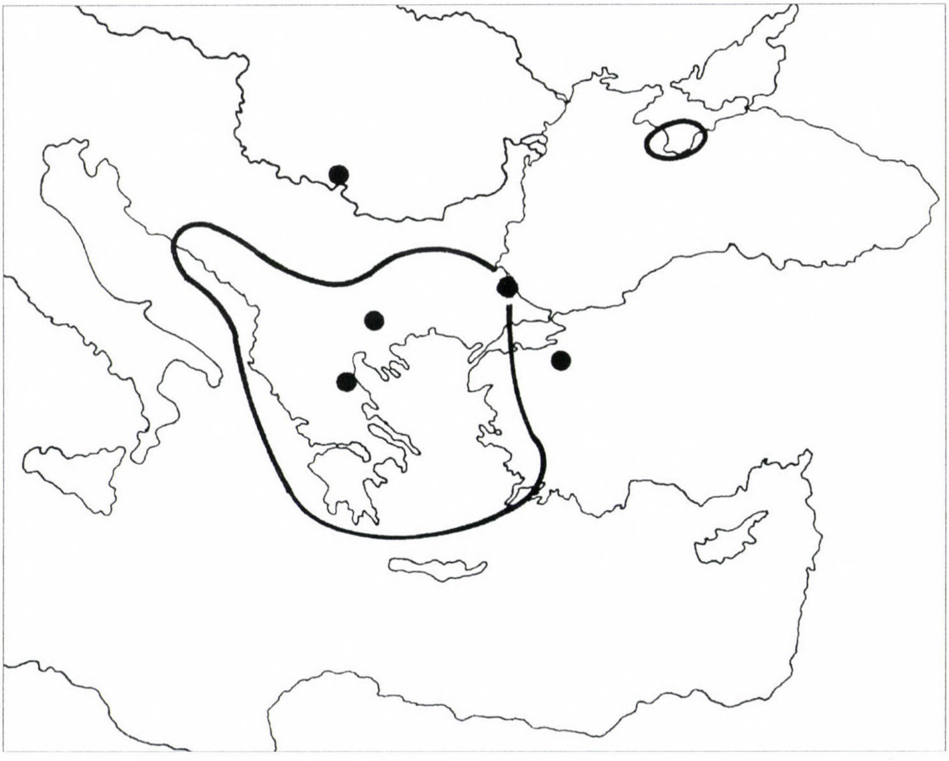


Fig. 4. Distribution of Pontomediterranean elements with a Balkan origin: encircled areas = *Dilar turcicus*, dots = *Nedroledon anatolicus*

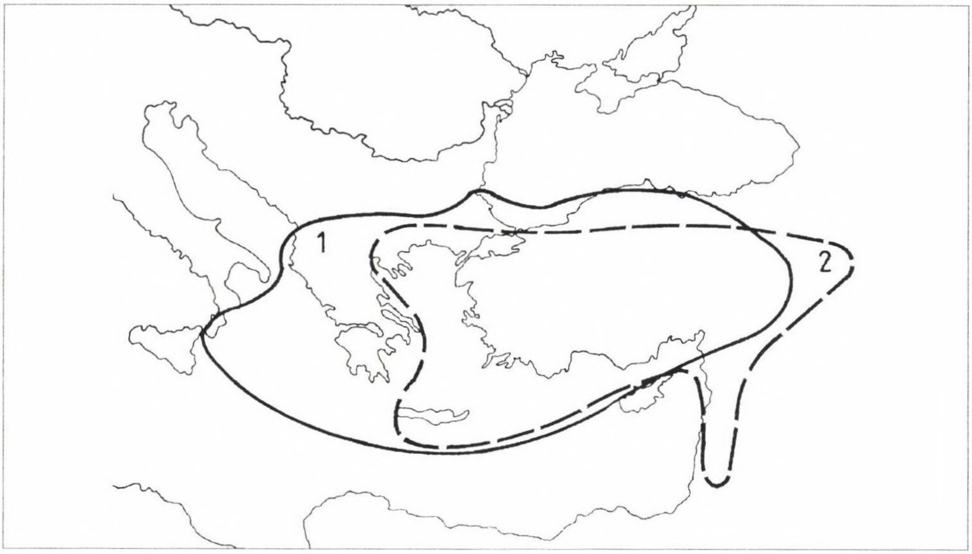


Fig. 5. Ranges of Pontomediterranean elements with an Anatolian origin: 1 = *Isoscelipteron fulvum*, 2 = *Hemerobius zernyi*

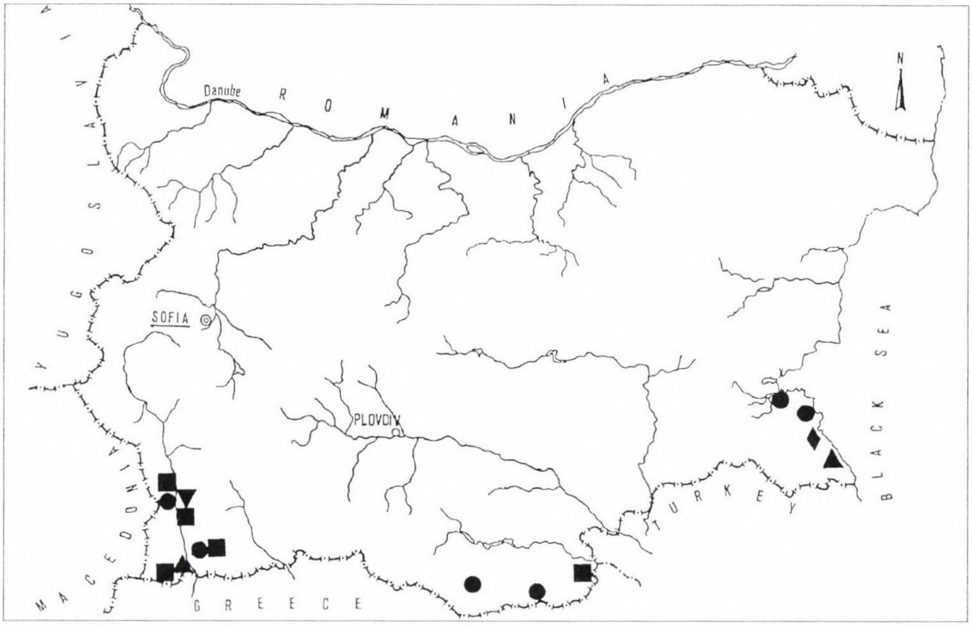


Fig. 6. Distribution of strictly stationary Mediterranean elements in Bulgaria, inhabiting only areas with strong Mediterranean influence in the country: ◆ = *Coniopteryx loipetsederi*, ● = *Isoscelipteron fulvum*, ▼ = *Hemerobius zernyi*, ■ = *Dichochrysa zelleri*, ▲ = *Nedroledon anatolicus*

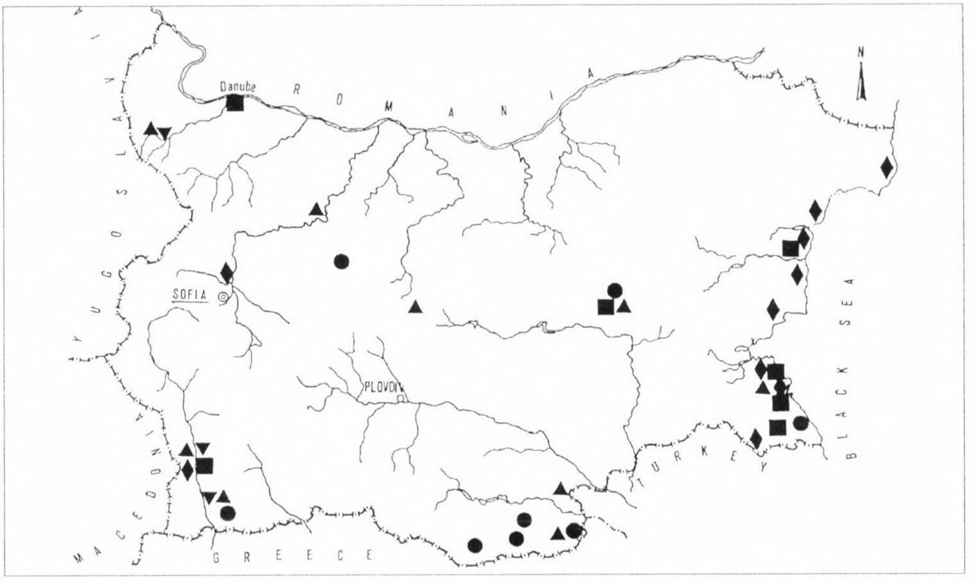


Fig. 7. Distribution of stationary Mediterranean elements in Bulgaria, inhabiting areas with Mediterranean and Submediterranean influence in the country: ● = *Coniopteryx drammonti*, ■ = *Mantispa aphavexelte*, ▲ = *Italochrysa italica*, ◆ = *Acanthaclisis baetica*, ▼ = *Delfimeus irroratus*



Fig. 8. Distribution of *Nevrorthus apatelios* in Bulgaria

Coast and some warm areas in North Bulgaria. Such species are *Coniopteryx drammonti* ROUSSET, *Mantispa aphavexelte* ASPÖCK et ASPÖCK, *Sympherobius klapaleki* ZELENÝ, *Italochrysa italica* (ROSSI), *Libelloides ottomanus* (GERMAR), *Delfimeus irroratus* (OLIVIER), *Acanthaclisis baetica* RAMBUR (Fig. 7). The only Balkan endemic species in Bulgaria is *Nevrorthus apatelios* ASPÖCK, ASPÖCK et HÖLZEL (Fig. 8). In contrast to the thermophilous Pontomediterranean species, it is a unique stenotopic inhabitant of cold mountain rivers at an altitude of 900–1000 m.

CONCLUSION

The species of Neuroptera occurring in Bulgaria can be divided into groups that originated, respectively, to the north and the south of the country. The species of southern origin are the Mediterranean elements and the eremial species. The species of northern origin are all the remaining categories originating from the Central European and the Siberian centres. The species of southern origin comprise 52% of the Bulgarian fauna of Neuroptera and slightly predominate over the species of northern origin.

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NEUROPTERIDA OF NORTHERN EUROPE

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The collections of Neuropterida (Megaloptera, Raphidioptera and Neuroptera) from Northern Europe in the museums in Denmark, Sweden and Finland were revised or identified. Many species are established for the first time in some provinces. *Chrysopa commata*, *Chrysopa formosa*, *Peyerimhoffina gracilis* and *Nineta pallida* are added to the species hitherto known in the area. So far, 82 species are known from Northern Europe. Of the individual national faunas that of Sweden has the most complete subset, 76 species, due to the presence of the tundral fauna in Lappmark (*Sialis sibirica*) and the thermophilous fauna in the southern provinces Skåne and Småland (*Osmylus fulvicephalus*) and the islands of Öland and Gotland (*Aleuropteryx loewii*). The territory of Denmark is not a part of the coniferous forest zone but belongs to the deciduous forest zone. Expectedly, some species, absent in Scandinavia, occur in Denmark (*Sialis nigripes*, *Helicoconis hirtinervis*, *Hypochrysa elegans*), while other species, typical for the taiga, do not occur here (*Sialis sordida*, *Raphidia ophiopsis*, *Hemerobius simulans*, *Wesmaelius mortoni*). Norway and Finland have a reduced Swedish fauna. *Chrysopa dasyptera* from Finland is the only species in the two countries which does not occur in Sweden.

Key words: Neuroptera, Megaloptera, Raphidioptera, Northern Europe, distribution, zoogeography

INTRODUCTION

The ice sheet retreated from Northern Europe at the end of the Würm Glacial Period about 10 000 years ago. The short period since that time has proved to be enough for the colonization of the territory with its whole recent fauna and flora. Humans occupied its southern parts at least 12 000 years ago.

Before discussing the composition and characteristics of the fauna of Neuropterida, it is necessary to consider the meaning of the term Northern Europe and of some other terms connected with this territory. The area under discussion covers the territories of Norway, Sweden, Finland, Denmark and of the faunistically poor Faeroe Islands, Iceland and Greenland, the last of which belongs zoogeographically to the Nearctic. The less explored northern part of European Russia, where the same species generally occur (see the last part of the zoogeographical analysis below), is not included. The terms used in the literature for these territories are as follows:

– the Scandinavian Peninsula for Norway and Sweden;

- Fennoscandia for the Scandinavian Peninsula, Finland and the adjacent parts of Russia;
- Scandinavia for Fennoscandia and Denmark;
- the Nordic countries for Scandinavia, Iceland and the Faeroes.

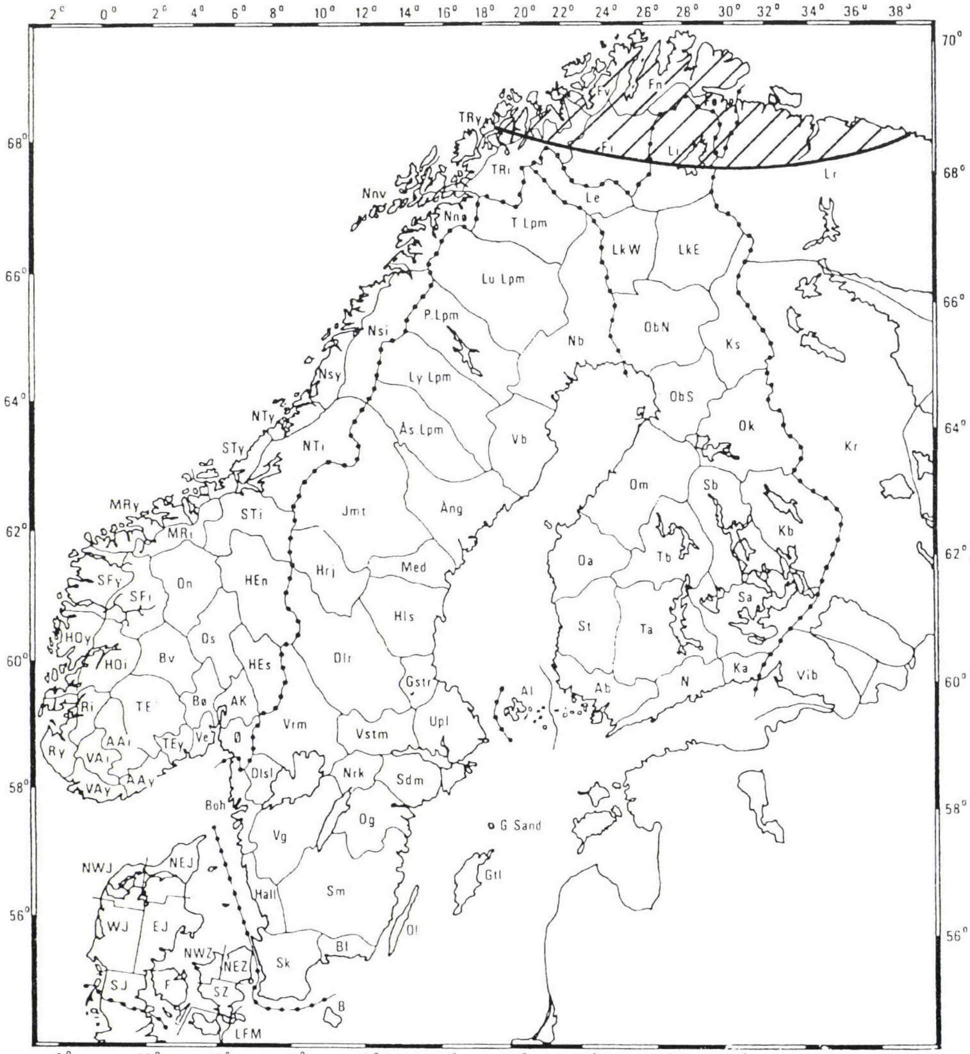


Fig. 1. Biogeographical provinces of Scandinavia (Denmark, Norway, Sweden and Finland). The hatched area is North Lapland, inhabited by 28 species. Figure and abbreviations after *Fauna Entomologica Scandinavica*

The most suitable term to use is Fennoscandia. It is divided in Western Fennoscandia or the Scandinavian Peninsula, consisting of Norway and Sweden, and Eastern Fennoscandia, consisting of Finland and Russian Karelia and Lapponia. The terms Scandinavia and Nordic countries have been used with different meanings and are quite confusing.

FAUNISTIC RESULTS

In the course of six years (1991–1997) I visited the main zoological and natural history museums in Denmark, Sweden and Finland several times and revised or identified the collections of Neuropterida from Northern Europe in: Zoologisk Museum, København; Naturhistorisk Museum, Århus; Zoologiska Institutionen, Lund; Naturhistoriska Riksmuseet, Stockholm; Eläinmuseo (Zoologiska Museet), Helsinki (Helsingfors).

The investigated specimens number over 5 600 in Danish museums, over 6700 in Swedish museums and over 12 000 in the Zoological Museum in Helsinki. On the basis of this rich material of ca. 24 000 examined specimens, some more detailed data on the species distribution in the three countries have been obtained. Many species have been established for the first time in some provinces. The biogeographical division of the investigated countries into 98 provinces (Fig. 1) has been used. A complete list of species distribution according to provinces in the three countries is in preparation.

Being a cradle of systematic entomology, Northern Europe is well-explored in respect to many insect groups. Neuropterida is not an exception to this rule. A series of species, widespread in the Palearctic or in Europe, were described from this region by LINNAEUS, FABRICIUS, WALLENGREN, REUTER. In the last hundred years there were published some generalizing papers (on the orders Megaloptera, Raphidioptera, Neuroptera and Mecoptera according to the current classification) for each country: Denmark – a monograph from Danmarks Fauna (ESBEN-PETERSEN 1929); Norway – a check list with distribution according to provinces (TJEDER 1945); Sweden – an outdated monograph (MJÖBERG 1909), a check list with distribution according to provinces (TJEDER 1940), a supplement to it (TJEDER 1953) and a check list according to the new nomenclature (TJEDER 1972); Finland, Russian Karelia and Kola Peninsula – a monograph from Fauna Fennica (MEINANDER 1962) and two additions to it (MEINANDER 1963, LAMMES 1977).

Notwithstanding the good exploration of Northern Europe, four species of chrysopids are added to the species hitherto known in the area. They are *Chrysopa commata* KIS et ÚJHELYI, *Chrysopa formosa* BRAUER, *Peyerimhoffina gracilis*

(SCHNEIDER) and *Nineta pallida* (SCHNEIDER). The last three species are locally distributed in the area and have definitely not been spread by man. The fact that *Peyerimhoffina gracilis* and *Nineta pallida* are established in two or three localities and *Chrysopa formosa* was known from Komi (ZAKHARENKO & SEDYKH 1981) and near Saint Petersburg (DOROKHOVA 1973) is a strong argument in favour of that opinion. *Chrysopa commata* has been confused with *Chrysopa phyllochroma* WESMAEL. The main distinguishing feature of the populations of both species in Central and Southern Europe is the presence of a black spot on the scapus of *Chr. commata* and the absence of such a spot in *Chr. phyllochroma* (KIS & ÚJHELYI 1965, KLEINSTEUBER & RÖHRICHT 2000 etc.). The verification by examination of male genitalia has shown that in Northern Europe *Chr. commata* rarely has a spot on its scapus. Most specimens of the two species do not differ in this characteristic. Besides by male genitalia, it is possible to distinguish the two species in both sexes by the lateral sutures of the thorax which are always black in *Chr. commata* and always green in *Chr. phyllochroma*. The same combination of characteristics (black sutures, absence of a spot on the scapus) is typical for almost all specimens of *Chr. commata* from England (PLANT 1997). The hitherto neglected *Chr. commata* is the more common of the two species in Northern Europe.

So far, 82 species altogether are known from this area. The number of the established species of Neuropterida (and separately of Neuroptera) in each country is given on Table 1.

ZOOGEOGRAPHICAL ANALYSIS

Most Neuroptera in the area are widespread in Europe or the Palearctic. The Raphidioptera, known for their high degree of endemism in the South (ASPÖCK *et al.* 1991), are very poorly represented in the northern parts of the range of this or-

Table 1. Number of species of Neuroptera and all Neuropterida recorded in Northern Europe

Country	Neuropterida	Neuroptera
Norway	63	55
Sweden	76	67
Finland	63	55
Denmark	64	58
Faeroes	2	2
Iceland	2	2
Greenland	3	3
Northern Europe	82	71

Table 2. Zoogeographical categories of North European species of Neuropterida according to their origin

Categories	Species	%
Oreotundral	1	1
Siberian	31	38
Siberian–Mediterranean	11	13
Siberian–Nearctic	9	11
Central European	8	10
Central European–Mediterranean	8	10
Mediterranean	14	17
Total	82	100

der. These are the reasons for the absence of any endemic species among Neuropterida in Northern Europe. The situation is the same in many other insect groups.

Despite the relatively low diversity of the habitats, the zoogeographical analysis of the species according to their origin classifies them into 9 categories (Table 2). The zoogeographical categories of DE LATTIN (1967) were mainly used. A hemerobiid (1% of all the species) is the unique non-arboreal species in the area. The Siberian faunal elements are most numerous. The Holarctic (Siberian–Nearctic) and the Siberian–Mediterranean species are represented approximately equally. The three last categories are united in a group originating from the Manchurian Subregion which consists of altogether 62% of the species. The Central European faunal elements and the Central European–Mediterranean species form a group originating from the western part of the Eurosiberian Subregion and comprising 20% of the species altogether. Some very expansive Holomediterranean faunal elements have also reached Northern Europe. Together with a few species from the secondary Mediterranean centres they form the group of the Mediterranean species comprising 17% of the species altogether.

The following species have typical ranges for the respective categories (all the Mediterranean species *sensu lato* in Northern Europe are of course expansive and therefore with extreme ranges):

- Oreotundral: the only representative is *Wesmaelius malladai* (NAVÁS);
- Siberian: *Xanthostigma xanthostigma* (SCHUMMEL), *Sisyra jutlandica* ESBEN-PETERSEN (with a range eastward to Baikal Lake and Yakutsk according to ZAKHARENKO, 1988), *Psectra diptera* (BURMEISTER) (presumably introduced in North America according to KEVAN & KLIMASZEWSKI 1986), *Nineta vittata* (WESMAEL), *Myrmeleon bore* (TJEDER);

– Siberian–Mediterranean: *Coniopteryx pygmaea* ENDERLEIN, *Hemerobius nitidulus* FABRICIUS, *Dichochrysa prasina* (BURMEISTER);
– Siberian–Nearctic: *Helicoconis lutea* (WALLENGREN), *Sisyra fuscata* (FABRICIUS), *Wesmaelius nervosus* (FABRICIUS)*;
– Central European: *Phaeostigma notata* (FABRICIUS), *Sisyra dalii* MAC-LACHLAN, *Nineta pallida* (SCHNEIDER);
– Central European–Mediterranean: *Sialis nigripes* PICTET, *Helicoconis hirtinervis* TJEDER, *Euroleon nostras* (FOURCROY);
– Mediterranean: *Subilla confinis* (STEPHENS) (Adriatomediterranean element), *Aleuropteryx loewii* KLAPÁLEK (least expansive northwards Holomediterranean element), *Coniopteryx borealis* TJEDER (most expansive northwards among the Mediterranean species).

The most complete picture of Scandinavian fauna of Neuropterida is given by the fauna of Sweden with 93% of the North European species. This is due to the

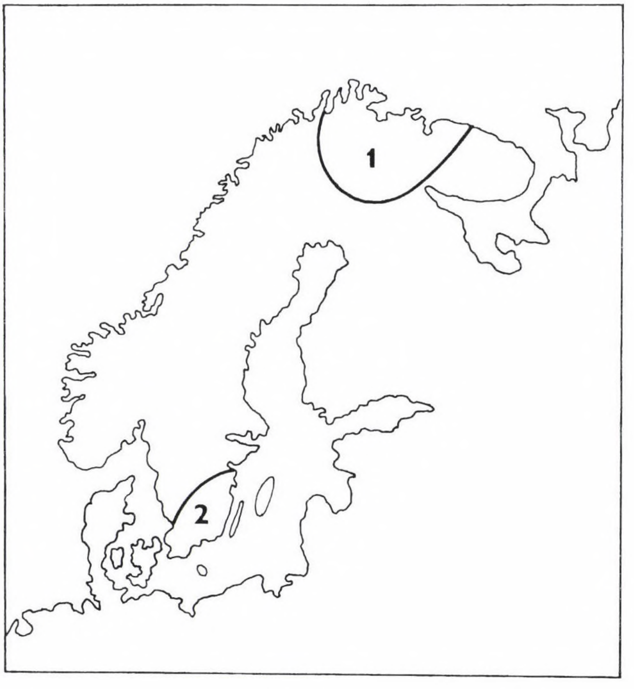


Fig. 2. The ranges of *Sialis sibirica* (1) and *Coniopteryx haematica* (2) in Fennoscandia. The former is a representative of the tundral fauna, the latter – of the thermophilous fauna

* *Wesmaelius nervosus* is conspecific with *W. disjunctus* (BANKS), *W. frostinus* (NAVÁS), *W. alexanderi* (NAKAHARA) and *W. melaleuca* (NAKAHARA), all the four synonymized by KLIMASZEWSKI & KEVAN (1987).

presence of two extreme faunas. On the one hand, the tundral fauna of Lappmark; and on the other hand, is the thermophilous fauna of the southern provinces of Skåne and Småland and the islands of Öland and Gotland (Fig. 2).

The extreme north of the Scandinavian Peninsula or the northern half of Lapland above 68–69° northern latitude (Fig. 1) is inhabited by 28 species or 34% of all the 82 species. Two thirds of the Holarctic species, half of the Siberian and less than half of the Siberian-Mediterranean and the Central European – Mediterranean species occur there.

The territory of Denmark is not part of the coniferous forest zone but belongs to the deciduous forest zone. This explains the absence of some species, typical for the taiga, e.g. *Sialis sordida* KLINGSTEDT, *Raphidia ophiopsis* LINNAEUS, *Hemerobius perelegans* STEPHENS, *Hemerobius simulans* WALKER, *Wesmaelius mortoni* (MACLACHLAN), *Megalomus hirtus* (LINNAEUS), *Nineta inpunctata* (REUTER). The same fact contributed to the appearance of the reverse situation. That is, other species, which are not distributed in Fennoscandia, occur in the discussed area only in Denmark, such as the Central European–Mediterranean *Sialis nigripes* PICTET, *Helicoconis hirtinervis* TJEDER and *Hypochrysa elegans* (BURMEISTER). The Central European *Nineta pallida* (SCHNEIDER), an inhabitant of the spruce forests which are not autochthonous in Denmark, also falls into this category. The most southern parts of the investigated area with mild climate are inhabited by some Central European *sensu lato* and Mediterranean *s. l.* elements. In their expansion northwards, the above mentioned Central European and Central European – Mediterranean species and the Atlantomediterranean element *Subilla confinis* (STEPHENS) in Northern Europe have only reached Denmark. Other species, such as *Osmylus fulvicephalus* (SCOPOLI), *Nothochrysa fulviceps* (STEPHENS), *Nothochrysa capitata* (FABRICIUS) and *Euroleon nostras* (FOURCROY) have reached Denmark and South Sweden, *Aleuropteryx loewii* KLAPÁLEK has only reached the islands of Öland and Gotland, and *Coniopteryx haematica* MACLACHLAN has only reached South Sweden.

Norway and Finland have a depauperate Swedish fauna which is devoid of most of the thermophilous southern species. Some Siberian species have also colonized Fennoscandia from the east with different intensity. Five species not occurring in the countries investigated have been established in North Russia. They are *Drepanepteryx algida* (ERICHSON), *Chrysopa walkeri* MACLACHLAN and three species with doubtful distributional data (*Coniopteryx hoelzeli* ASPÖCK*, *Chrysopa hummeli* TJEDER and *Chrysopa reichardti* BIANCHI *sensu* ZAKHARENKO =

* *Coniopteryx hoelzeli* was confused with *Coniopteryx pygmaea* ENDERLEIN *sensu* GÜNTHER – see the synonymic list in MEINANDER 1990 sub *C. pygmaea*. Both species under other names were not correctly separated by ZAKHARENKO & KRIVOKHATSKY (1993).

altaica HÖLZEL). If the spread of the species from east to west is examined, it is evident that some species have reached different longitudes (Fig. 3). Thus *Drepanepteryx algida* has reached westward Uhta in Central Komi (ZAKHARENKO & SEDYKH 1981), *Chrysopa walkeri* (perhaps the spread has passed rather from southeast than from east) has reached Ladoga Lake in Russian Karelia, i.e. Eastern Fennoscandia (HULDÉN *et al.* 1977), *Chrysopa dasyptera* MACLACHLAN – Southeastern Finland (MEINANDER 1962), *Sialis sibirica* MACLACHLAN – Lapland (ASPÖCK *et al.* 1980), *Psectra diptera* (BURMEISTER) – Sweden (TJEDER 1940). *Inocellia crassicornis* (SCHUMMEL) occurs only in restricted territories in Central Sweden (Dalarna – TJEDER 1940 and Hälsingland – HEDSTRÖM 1985)* and Russian Karelia (Kuusamo – HULDÉN *et al.* 1977). However the distribution of most species covers the whole Fennoscandia from its western to its eastern boundaries.

Chrysopa dasyptera is the only species among those of Finland and Norway which does not occur in Sweden. The range of this remarkable species (Fig. 4) ex-

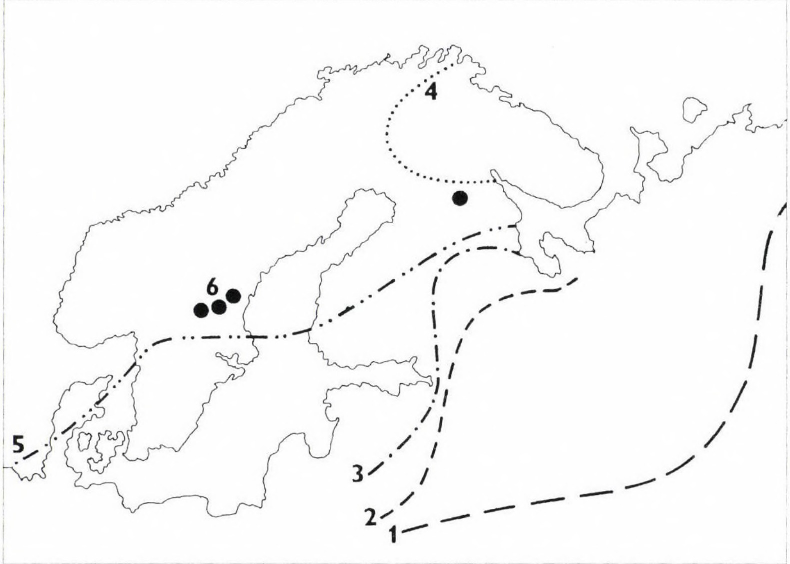


Fig. 3. Western and northwestern range borders of some species in Northern Europe: 1 = *Drepanepteryx algida*, 2 = *Chrysopa walkeri*, 3 = *Chrysopa dasyptera*, 4 = *Sialis sibirica*, 5 = *Psectra diptera*, 6 = the disjuncted range of *Inocellia crassicornis* in Fennoscandia (for other localities of *In. crassicornis* in North Sweden see a footnote in the text)

* It seems *In. crassicornis* is wider spread in Sweden. During the print of this paper, the species was established on the basis of larvae and one female from traps on trees in four other provinces in North Sweden: Västerbotten, Norrbotten, Lycksele Lappmark and Pite Lappmark (BERGSTEN & PETTERSSON 2000). The new localities are not shown on Fig. 3.



Fig. 4. Distribution of *Chrysopa dasyptera*

tends from Southeastern Finland (MEINANDER 1962)*, East Poland (DOBOSZ 1996), Hungary (SZABÓ & SZENTKIRÁLYI 1981)** and Romania (PAULIAN 1996) through European Russia (Saint Petersburg District – DOROKHOVA 1973, Komi – ZAKHARENKO & SEDYKH 1981, Middle Volga – KOVRIGINA 1978) to North and Central Kazakstan (DOROKHOVA 1977), West Siberia (Krasnoyarsk District – ZAKHARENKO & KRIVOKHATSKY 1993) and North Mongolia (Chövsgöl District – STEINMANN 1971 and Central District – DOROKHOVA 1977).

There are some other interesting species in chorological respect which give a specific character to the North European fauna of Neuropterida: *Sialis sordida* KLINGSTEDT, *Sialis sibirica* MACLACHLAN, *Helicoconis hirtinervis* TJEDER, *Sisyra dalii* MACLACHLAN, *Sisyra jutlandica* ESBEN-PETERSEN, *Wesmaelius balticus* (TJEDER), *Nineta inpunctata* (REUTER).

*

Acknowledgements – I wish to express my grateful thanks to the museum direrctors or curators who allowed me to check and identify the North European material from their collections: Prof. NIELS KRISTENSEN (Zoological Museum, Copenhagen), Prof. MARTIN MEINANDER (Zoological Mu-

* DOBOSZ (1996: fig. 2) incorrectly includes Southwestern Finland and Aland Islands in the range of *Chrysopa dasyptera*. This is due to an unintentional mistake in MEINANDER (1962: map 32) where the symbols of *Chrysopa dasyptera* and *Chrysopa dorsalis* BURMEISTER were reversed.

** According to F. SZENTKIRÁLYI (pers. comm.) the occurrence of *C. dasyptera* in Hungary needs confirmation.

seum, Helsinki), Dr ROY DANIELSSON (Zoological Department, University of Lund), Dr BERT VIKLUND (Swedish Museum of Natural History, Stockholm) and Dr PETER GJELSTRUP (Museum of Natural History, Århus). The study was supported by grants from the European Commission and the Carlsberg Foundation and by the Academy of Finland and the Royal Swedish Academy of Sciences.

These new faunistic data from my revisions of the museum collections are part of a project on Neuropterida and Mecoptera of Northern Europe with the participation of Prof. NIELS KRISTENSEN, Prof. MARTIN MEINANDER and Dr LITA GREVE-JENSEN from the Nordic countries as well as Prof. HORST ASPÖCK, Doz. ULRIKE ASPÖCK and Prof. JOHANN GEPP from Austria.

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Amphistomes of the World
A check-list of the amphistomes of vertebrates

O. Sey

The amphistomes are one of the rare groups of digenetic trematodes which have a broad spectra of the definitive hosts together with a wide geographical distribution, forming a continuous evolutional lineage from fishes to mammals. At the same time, some species of them are causative agents of devastating disease of domestic and wild animals, mainly ruminants. Therefore, amphistomes may have professional and practical interests for research and thus a great number of information has been accumulated on their classification and biology. The intention of this check-list is to bring together a comprehensive list of the amphistomes, presently known and sources of references of their hosts and geographic distribution (87 pages). This list consists of three main parts. In the first "Parasite/host check-list" (137 pages), parasites were listed under their scientific names, followed by the synonyms, then the name of the authorship as well as the name of the countries from which they were reported. In the second "General host/parasites check-list" (31 pages), host were listed systematically under their scientific names from fishes to mammals, followed by amphistomes described in them in alphabetical order. In the third "Host/parasites check-list by countries" (63 pages), countries were listed alphabetically, hosts systematically and their parasites alphabetically. When it seemed to be necessary some comments were given and they are found in Chapter 7 "Notes" (5 pages). Three indexes (parasite, host and countries) are added to the list (29 pages).

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AUTECOLOGY AND BIOLOGY OF NEMOPTERA SINUATA OLIVIER (NEUROPTERA: NEMOPTERIDAE)

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Specimens of *Nemoptera sinuata* were reared from eggs to second instar larvae in captivity, and observations on imagos were carried out in the Struma Valley, Bulgaria. The adults occur in open sunny places in river gorges and feed only on pollen. They are most active at noon between the middle of May and the end of June. The males occur one week earlier than the females. The eggs are laid directly on the ground, most often in the morning. They are spherical (rare among Neuroptera), white, opaque, with one micropyle. Up to 70 eggs are laid by a female over a period of 10 days. The egg stage usually lasts from 23 to 25 days. The lid is cut off by an eggbreaker during hatching. The newly hatched larvae are 2.0–2.1 mm long, are terricolous and always buried themselves by digging to 1 cm in depth. The larvae rejected living or freshly killed arthropods, or roots and blossoms of plants. They were only observed to take water and vegetable sap. The longest surviving larva moulted in September (first instar lasts 72 days) and hibernated. It increased in length to 5 mm and died in April after being reared for nine months.

Key words: *Nemoptera sinuata*, imaginal ethology, feeding, oviposition, egg, hatching, larva

INTRODUCTION

Investigations on the autecology and the early stages of *Nemoptera sinuata* OLIVIER, which are reported here, were carried out more than 30 years ago. They included a rearing from imago to second instar larva. The observations and conclusions on the behaviour, feeding and habitat of the adults and the larvae were the subject of my thesis (POPOV 1967). These observations were not published because I expected to continue the rearing of a mature larva, prepupa and pupa.

At the time of the investigations there was no information on either the egg and larva, the biology and habits of the larva, or the feeding and behaviour of the imago. There were almost no detailed data on the whole family Nemopteridae *sensu* MONSERRAT (1996), now comprising 90 taxa. The development and the preimaginal stages of a number of species, mainly from the closely related family Crocidae distributed in the southern Hemisphere, has recently been investigated by MANSELL (1973, 1981, 1983*a, b* etc.) and of *Nemoptera bipennis* (ILLIGER) and all the Spanish representatives of both families by MONSERRAT (1983*a, b*, 1985*a*, 1996). A mature larva of *Nemoptera coa* (LINNAEUS) from Greece was reared to imago by TRÖGER (1993). Their results are very similar to my observations on

Nemoptera sinuata. The pollenophagy of the adults of *N. sinuata* was observed for the first time and my suggestion (POPOV 1967), that the structure of the mouthparts in the whole family Nemopteridae *sensu lato* proves feeding only on pollen, was confirmed by field observations of some authors, *e.g.* MONSERRAT (1985*b*) on *N. bipennis* and PICKER (1987) on *Palmipenna aeoleoptera* PICKER. Also my proposal (POPOV 1973) that Nemopterinae and Crocinae should be regarded as distinct families, if essential differences in all stages were confirmed after the discovery of the larvae of other genera, was realized by MONSERRAT (1996).

IMAGO

The observations on the imago of *N. sinuata* were carried out in 1965–1967 in the field in Kresna Gorge along the valley of Struma River in southwestern Bulgaria and in captivity in Sofia. For this purpose living nemopterids were transferred to broad glass tubes containing blooming flowers. They were reared between glass and cloth screen with blossoming plants in glass jars with water.

The imago of *N. sinuata* occurs in meadows and open sunny places with Mediterranean and Submediterranean vegetation in sheltered river gorges. The adults prefer the yellow blossoms or racemes of plants, such as *Achillea coarctata* POIR. (Asteraceae), *Alyssum murale* WALDST. et KIT. (Brassicaceae) and *Hypericum rumeliacum* BOISS. (Hypericaceae).

The flight period usually lasts from the middle of May to the end of June with the earliest and latest collecting dates May 2nd and July 8th. The phenological maximum is in the first ten days of June. The males occur one week earlier than the females.

The flight of *N. sinuata* is easy and graceful, but slow. The flapping is done only with the forewings, while the hindwings remain static. The coloration of the wings provides effective camouflage and the adults are difficult to see. The imagos begin to fly in the morning and are most active at noon in sunny weather. In cloudy weather they remain perched on the blossoms with their forewings wide open and their hindwings directed at an angle of 40–45° and slightly twisted towards the ends. When it rains, they retreat below the blossoms with their forewings up above the back.

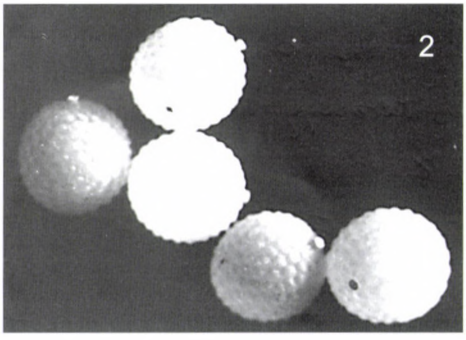
N. sinuata is a diurnal insect. It flies, feeds and lays eggs only during the day. When reared in a room or in a cage, the adults always fly and settle on more illuminated or sunlit spots.

The specimens reared under different conditions in captivity lived from 5 to 13 days. Taking into consideration that they were caught in the middle of the flight

period of the species in the same locality and that all females had already been fertilized and were laying eggs, it can be assumed that in the field the life span of the adults is nearly 20 days.

The observations in 1965 showed that the imago of *N. sinuata* feeds exclusively on pollen. It inserts its mouth parts into the floret cornet of *Achillea* and tears off the pollen bags. The clypeus and labrum of the insect become covered with pollen. The imago occasionally collects pollen with the tarsi of the forelegs, wiping the tarsi through its mouthparts and swallowing the pollen. The mouthparts of *N. sinuata* and Nemopteridae *s. l.* as a whole have a tearing function rather than chewing and are structured to feed only on pollen (Fig. 1). The main role in feeding is played by the maxillae and the labium, while the almost immovable mandibulae and labrum have no part at all. The maxillae move simultaneously and quickly up and down due to the strongly movable articulation between the stipes and the palpifer. The same movements are executed by the strongly elongated labium. During feeding the rostrum projects into the floret, opening it, and the distal parts of the maxillae and the labium, namely both galeae and both pairs of palpi, with their upward movements draw out the pollen grains from the bottom of the chalice to the mouth opening. The pollenophagy in *N. sinuata* was also confirmed by the analysis of the gut contents and the excrements of the imago. Both the proventriculus and the ventriculus were filled with whole grains, and the excrements with their shells, which are the same as the reference sample of pollen grains of *Achillea coarctata*. Thus the pollenophagy in nemopterids was recorded for the first time and accepted by analogy for the whole family because of the structure of the mouthparts. This was confirmed by the finding of pollen in the gut contents of a number of species by TJEDER (1967) and by observations on other species by other authors (see Introduction).





Figs 1–2. *Nemoptera sinuata*: 1 = feeding on a raceme of *Achillea coarctata*; 2 = eggs

EGG

The eggs are usually laid in the morning. The female, with half open wings and a drooping abdomen, perched on blossoms or racemes of plants, *e.g. Achillea*. An egg appears every two minutes and after 4–6 eggs the female moves on to another raceme. The eggs fall directly to the ground or on dry vegetation. They are not adhesive, but elastic and bounce when coming into contact with a hard surface, as for example a piece of wood.

The eggs (Fig. 2) are spherical, snow-white, opaque, lustreless, with a diameter of 0.83–0.90 mm and with one micropyle. It should be mentioned that the genus *Nemoptera* is one of the few genera among all Neuroptera with spherical shape to the eggs. The chorion is highly sculptured, with irregular hexagonal convexities on the surface, which touch one another. About 30 convexities have been counted on the periphery of the egg and about 180 convexities on the whole egg surface. When seen from above, the micropyle has the form of a disk; in profile it looks like a cornet with no opening in it.

According to the observations in the laboratory, the number of eggs laid by one female is up to 70. Eggs are laid for about 10 days during the total life span of 20 days of the female. Within the first five days the number gradually drops from 14 to 9 eggs per day.

The egg stage covers 20–26 days on the basis of the rearings in 1965–1967, most frequently 23–25 days at air temperatures of 19–27° in the laboratory. The duration of the egg phase depends on the temperature. For example, 16 eggs were put in a refrigerator for 10 days at 6° and the larvae were hatched with 12 days delay. While at 30–32° temperatures the hatching occurs after 19 days.

LARVA

After the fifteenth day the egg becomes light pink and then grey on one side. The embryo lies in the form of a semicircle in the egg. A polar lid with the micropyle in the centre is opened during hatching. The lid is cut off by an egg-breaker on the larval clypeus. The egg-shell breaks by pressure from the dorsal surface of the larva. The split becomes almost a complete circle and the lid separates without breaking from the egg. The larva pulls out the dorsal part of the thorax first, then the head in two or three minutes and the abdomen at the end. Filling its tracheae with air, the larva becomes bigger in one to two hours and begins to move slowly, until it hides.

The newly hatched larva is 1.7–1.8 mm long or 2.0–2.1 mm long including the jaws. It is dorsally grey, with an oblong transverse dark spot on both sides of the median line of every thoracic and abdominal segment and a large, almost black spot on the head. The body densely is haired with long and short setae: macrotrichia, dolichasters and micrasters. The length of some of the macrotrichia is equal to almost one third of the body length. The head is trapezium-shaped to rectangular, 0.38 mm long and 0.55–0.65 mm wide, and occupies together with the jaws more than one third of the body in length. The slowly movable head moves only in a vertical direction. The jaws are large, broad, gradually curved inwards, sharply-pointed at the apices, with a flat and rounded outer margin covered with long macrotrichia, with 9 short dolichaster-like setae on the inner margin. The eye spot consists of 7 stemmata. Antennae are composed of one small basal segment and one large, curved, rounded and dilated segment. Palpi labiales are very short, four-segmented. Legs are short, with hard spines. The abdomen is broad and ten-segmented. The first instar larva of *N. sinuata* from Bulgaria is very similar to that of *N. bipennis* reared by MONSERRAT (1996). The former differs from the latter in the shape of the black spot on the head and in its wide and short abdomen.

I could not find any living larvae in the field, to define their habitat. When reared in captivity in 9 microhabitats (soil, sand, peat, leaves, etc.), the larvae always buried themselves by digging to 1 cm depth. They are consequently assumed to be terricolous.

For the entire duration of rearing (9 months) no answer was found to the question of how the larvae feed. They were offered the common caterpillars of *Plodia interpunctella* (HÜBNER), larvae of *Tenebrio molitor* LINNAEUS, imagos of *Drosophila* FALLÉN, *Musca domestica* LINNAEUS, *Sitophilus granarius* (LINNAEUS), as well as field-collected Collembola, Acarina, Psocoptera, Psyllina, Formicidae and various families of Diptera. The larvae of *Nemoptera* paid no attention either to living, or to freshly killed small arthropods, or to cut out pieces of those with body fluids. The result was also negative with Enchytraeidae, *Tubifex* LAMARCK, segments of Lumbricidae, living snails, as well as with mellow roots of herbaceous plants or their blossoms. The larvae were only observed to dip the apices of their jaws into drops of water and into the sap of newly cut carrots or potatoes. The typical predatory feeding habit as well as the parasitic one is not characteristic at least for the first instar larva of *N. sinuata*. The hypothesis of MONSERRAT and MARTINEZ (1995) on possible myrmecophily of Nemopteridae *s. str.* in the larval stage seems quite probable bearing in mind the rejection of a wide range of prey by the larvae of *N. sinuata* in Bulgaria and of *N. bipennis* and *Lertha sofiae* MONSERRAT in Spain, as well as the experiments for harvesting of eggs and eventually of young larvae by some ant species in their nests. The successful feeding of

the third instar larva of *Nemoptera coa* in captivity by TRÖGER (1993) only appears to contradict the hypothesis. Feeding on ant larvae may be necessary and obligatory for only the first and eventually the second instar larvae of *Nemoptera*.

The longest reared larva moulted on 23rd September; the instar lasts 72 days. The second instar larva has a more elongated body, darker coloration and a relatively smaller head, corresponding to one fifth of the body. Every segment has a small tubercle laterally with tufts of black macrotrichia.

The larvae move slowly and clumsily, and only forwards. They cover about 6 cm over 30 seconds. The larvae always try to bury themselves, going forward with their head. When touched, they become immovable and appear to be dead. This lasts from half a minute to one minute or rarely two minutes.

The longest living larva was left to hibernate at the end of November. A small bowl with sand was put in a bigger bowl with regularly moistened sand at temperatures between +5° during the night and 10° during the day. The larva spent the winter in the sand in the form of a crescent without making any nest around itself. After being taken out of the sand, it would become active after several minutes. After the hibernation, it still did not accept food. The larva died on 9th April next year after being reared for nine months. Although no feeding was observed, the larva increased in size from 2 mm at hatching to 4.1 mm at moulting to 4.8 mm before hibernation and to 5 mm in the end of its life.

In conclusion, the known first half of the life cycle afforded an opportunity to speculate on the development of *N. sinuata*. It probably passes through a second moulting at the beginning of summer, hibernation of the third larva, forming of a cocoon in April and emerging of the imago after one month total duration of the prepupal and pupal stages.

*

This report was presented on the Sixth International Symposium on Neuropterology held in Helsinki in 1997. Only an abstract of it has been published in the Proceedings of the Symposium (POPOV 1998) because I intended to include the original data in a detailed comparative review on the eggs, larvae and development of nemopterids. As that has not been realized, the full report is published in the present volume.

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Diaria itinerum Pauli Kitaibelii III. 1805–1817

Edited by László Lőkös

Paul Kitaibel, the renown Hungarian botanist completed 17 longer and several shorter journeys in the 18–19th century during which he wrote a very detailed travel diary. Leaving Pest or Buda, from the boundary of the town he kept a scientifically very thorough itinary making it as detailed as possible. His observations covered the entire geological and natural geographical aspects of the landscape, laying special emphasis on rocks, minerals, soil, running and still waters. He specifically examined mineral waters, the first analyses of which were made on the spot with his travelling laboratory kit. The most painstaking and thorough observations were made on the plants. With profound thoughtfulness he made his notes also on the animals he saw. Besides the known plants he reported the discovery of numerous new plant species in his diary. He complemented the species list with phytogeographical, ecological, cenological observations still valid today, well preceding the scientific character of his age. He jotted down everything he experienced.

His small note-books of 12–16 pages each build up his diary, which is a valuable storehouse of information on the economy, agriculture, industrial production, mining, trade and traffic of the day. Ethnography did not fall far from his interest either, so he wrote colourful reports on wedding customs, popular life and rural feats.

Kitaibel's travel diary was written in German and Latin. The text is written with the orthography used by Kitaibel, and the same holds also for the species names. The illegible, consequently unprinted parts are indicated by a row of dots (...), while the uncertain readings of some words are (?) question marked.

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POPULATION DYNAMICS AND SEASONAL OCCURRENCE OF ADULTS OF CHRYSOPERLA EXTERNA (HAGEN, 1861) (NEUROPTERA: CHRYSOPIDAE) IN A CITRUS ORCHARD IN SOUTHERN BRAZIL

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Studies of the population dynamics of *Chrysoperla externa* (HAGEN, 1861) adults were carried out in in Lavras, Minas Gerais, Brazil, in a citrus orchard, with the influence of precipitation, relative humidity and maximum, minimum and average temperatures on its population density being evaluated. Sampling was made weekly with an entomological net on 20 citrus trees in an area of ca. 2 ha, between 13:00 and 17:00 h, from May 1992 to April 1996. Annual sampling records for adults collected were 853, 629, 575 and 313, respectively, with a decreasing population trend during the period, mainly in the fourth year of study. An increase in the number of adults collected was observed from May to September, with peaks of 687 (80.5%), 344 (54.7%), 328 (57.0%) and 107 (34.2%) in September of 1992, 1993, 1994 and 1995, respectively. A remarkable decrease in the number of insects collected was observed in the months after September, with no insects or only few ones collected from November to March, December to February being the most critical period. There was an increase in the number of adults with the decrease in precipitation, relative humidity and temperature, with minimum and average temperature influencing the most.

Key words: *Chrysoperla*, Chrysopidae, Neuroptera, citrus, weather factors, seasonal occurrence

INTRODUCTION

The Chrysopidae stands out in citrus agro ecosystems for their occurrence in orchards in several countries; however, their presence is conditioned to many biotic and abiotic factors, with weather greatly affecting their seasonal abundance (ADAMS & PENNY 1985).

Most research on Chrysopidae carried out in Brazil is limited to the observations on their occurrence as organisms preying upon arthropod pests in several crops, in addition to some basic studies related to their biology. There is little information on the efficiency of these insects as agents regulating populations of plant-feeding arthropods, as well as their contribution in the maintenance of equilibrium in ecosystems. Thus, their population dynamics and the weather factors, which favor or delay their development and their population increase, have been poorly studied under natural conditions. In this work, *Chrysoperla externa* (HA-

GEN, 1861) adults were investigated in a citrus orchard as to the influence of weather factors upon their population dynamics.

MATERIAL AND METHODS

The work was carried out in a citrus orchard of ca. 2 ha in the Universidade Federal de Lavras (UFLA), Minas Gerais, Brazil. The influence of precipitation, relative humidity and maximum, minimum and average temperatures upon populations of *Ch. externa* was evaluated by periodical collections of adults in orange (*Citrus sinensis* OSBECK) trees of Natal, Valencia and Baía cultivars and on mandarin (*Citrus reticulata* BLANCO) trees.

The adults were collected weekly between 13:00 and 17:00 h, over the period from May 1992 to April 1996. Twigs and foliage of all quadrants of the trees were lightly shaken in a way that all surface of the plant canopy was sampled in order to displace the insects, which were then captured using a 30 cm diameter entomological net.

The influence of weather factors on the population density and seasonal occurrence of *Ch. externa* adults were analyzed by a simple correlation analysis (SOKAL & ROHLF 1995) among weather data of the collecting day and the number of adults captured weekly. In order to investigate the simultaneous influence of the climatic factors studied, a multiple linear regression analysis was accomplished; taking into account the total number of adults captured weekly over the four years' evaluation, in terms of precipitation, relative humidity and average temperature.

RESULTS AND DISCUSSION

Population dynamics

The number of adults of *Ch. externa* collected varied during the year, with a seasonal influence and a difference in the number of insects caught in each year being observed. The annual total number of insects collected in 1992, 1993, 1994, 1995 and 1996 decreased year after year (853, 629, 575 and 313 specimens, respectively), with a great reduction in the fourth year of evaluation (45.6% as compared to the third year) (Table 1). In Praha-Ruzyně, Czech Republic, HONĚK (1977) also recorded variations in the relative abundance and composition of the complex of aphid-feeding insects in evaluations accomplished in four consecutive years.

In the surveys carried out in the first year, adults of *Ch. externa* were present in 46% of the samples, followed by 56%, 62% and 60% in the following years. Their presence was found in 112 samples, out of the 200 accomplished during the four years.

The number of Chrysopidae specimens collected was 1682, 905, 722 and 569 consecutively in the years of study, with 853 (50.7%), 629 (69.5%), 575 (79.6%) and 313 (55%) being *Ch. externa*, hence the most common species present in that orchard.

Table 1. Total number of adults of *Chrysoperla externa* collected over the period from May/1992 to April/1996 on citrus trees. Lavras, MG, Brazil

Months	Total/month				Period 1992/96		
	1992/93	1993/94	1994/95	1995/96	Total/month	Mean/month	Mean/collection
May	3	5	33	14	55	13.8	3.6
Jun	3	25	38	27	93	23.3	5.3
Jul	13	75	10	55	153	38.3	10.0
Aug	125	153	150	68	496	124.0	29.1
Sep	687	344	328	107	1466	366.5	77.4
Oct	19	13	5	24	61	15.3	3.9
Nov	1	0	6	7	14	3.5	0.9
Dec	0	0	1	0	1	0.3	0.1
Jan	0	2	0	0	2	0.5	0.1
Feb	0	0	1	0	1	0.3	0.1
Mar	0	7	1	1	9	2.3	0.5
Apr	2	5	2	10	19	4.8	1.2
Total	853	629	575	313	2370		

In general, there was an increase in the number of adults captured from May on, with the peak in September, with totals of 687 (80.5%), 344 (54.7%), 328 (57.0%) and 107 (34.2%) insects, in the years of 1992, 1993, 1994 and 1995, respectively (the values between parenthesis correspond to the percent over the total number of insects captured in each year). Subsequently, there was a marked reduction in the number of insects with a low occurrence or even their absence in the orchard from November to March, the most critical period being that from December to February. Sampling carried out during the 4-year study period demonstrated that adults were present in all months of the year, although only four specimens were collected during summer months (two in January 1994, one in December 1994, and one in February 1995) (Table 1). Similar results were obtained by LARA *et al.* (1977) who observed, for *Chrysopa* sp.*, a peak in August of 1974, when 192 individuals were collected, corresponding to 59.1% of the total captured throughout the year with a marked reduction in insect number taking place in September, with only 38 individuals (11.7% of the total).

* This species must belong to another genus of Chrysopidae, such as *Chrysopodes* NAVÁS, 1913; *Chrysoperla* STEINMANN, 1964; *Ceraeochrysa* ADAMS, 1982; or *Plesiochrysa* (ADAMS, 1982), since ADAMS and PENNY (1986) and BROOKS and BARNARD (1990) mentioned that the genus *Chrysopa* LEACH, 1815 "*sensu stricto*" doesn't occur in the South-American fauna.

Influence of weather factors

The populations of *Ch. externa* showed great sensibility to weather variations occurring over the period studied, with a significant negative correlation ($P \leq 0.05$) being verified between each weather factor and the catches. There was an increase in the number of insects, associated with a decrease in the precipitation, relative humidity and temperature. Within the years evaluated and of the ranges of variation occurring for those weather factors, the driest (low precipitation and relative humidity) and coldest (low temperatures) periods caused the increase of their population density.

Precipitation. This factor negatively affected the population of adults, being a factor of importance in the occurrence of these insects among the years (Fig. 1). The correlation coefficient ($r = -0.35$) obtained by the analysis between this factor and the number of *Ch. externa*, confirmed that the increase in precipitation caused a significant decrease in the number of adults caught. The results showed the importance of seasonality of precipitation for the populations of *Ch. externa* similar to those obtained by HONĚK and KRAUS (1981), who demonstrated a negative effect of precipitation upon the number of adults of *Chrysoperla carnea* (STEPHENS, 1836) caught in light traps in Praha-Ruzyně, Czech Republic. However, in a study from Itaguaí, RJ, GOUVEA *et al.* (1996*a*) observed that precipitation did not interfere in the population dynamics of *Chrysoperla* sp., with no significant correlation among these factors. In the same way, LARA *et al.* (1977) did not find a significant



Fig. 1. Population dynamics of *Chrysoperla externa* adults over the period of May/1992 to April/1996 on citrus in relation to precipitation. Lavras – MG, Brazil

correlation between precipitation and population density of adults of *Chrysopa* sp., in Jaboticabal, São Paulo, Brazil.

Relative humidity. There was a negative correlation between the number of insects collected and relative humidity (r = -0.35). The driest conditions significantly increased the population density of *Ch. externa* in the area, enabling the catch of a greater number of specimens (Fig. 2). Likewise, LARA *et al.* (1977) verified a negative correlation between relative air humidity and the populations of *Chrysopa* sp. in citrus orchards in Jaboticabal, São Paulo, showing it to be the weather factor of greatest importance upon the population fluctuation of that chrysopid. TAUBER and TAUBER (1983) also stressed the effects of that factor upon the development, geographic distribution and the relative abundance of *Ch. carnea* and *Chrysopa rufilabris* (BURMEISTER, 1839) (= *Chrysoperla rufilabris*).

Temperature. In general, this was the climatic factor which influenced population dynamics of *Ch. externa* adults the most, the observation being that lower temperatures caused an increase in the number of insects caught.

Temperature may affect the geographic and seasonal distribution of several species of insects (TAUBER & TAUBER 1983). According to CAMMEL and KNIGHT (1992), this factor may have great influence upon the total number of eggs produced as well as affect the oviposition behavior of each individual. Firstly, through its effect on the development of the immature stages of a species by affecting the size and weight of adults and, in females, often there is a close relationship between the size of the body, number of ovarioles and eggs produced. Secondly, it

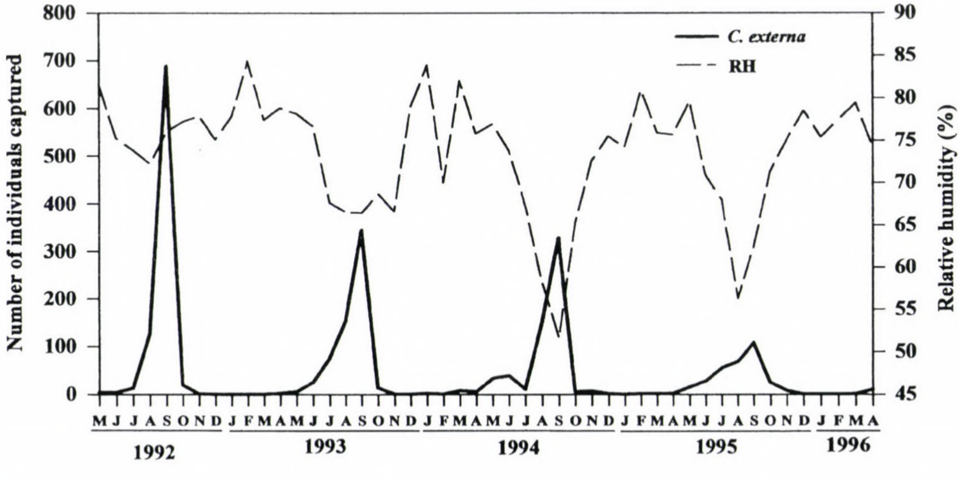


Fig. 2. Population dynamics of *Chrysoperla externa* adults over the period of May/1992 to April/1996 on citrus in relation to relative humidity. Lavras – MG, Brazil

may considerably affect the adults' fecundity during the reproductive phase. This, more than any other physiological function, is adversely affected by temperature threshold.

In contrast to the results obtained in this research on *Ch. externa*, was verified by BUSOLI (1992), a positive correlation between temperature and *Chrysopa* sp. populations in Monte Alto, São Paulo. His results also differ from those found by LARA *et al.* (1977) who found no significant effect of the maximum temperature on the populations of *Chrysopa* sp. present in a citrus orchard in Jaboticabal, SP. In research by PAIVA *et al.* (1994), it was also found that both adults and larvae of chrysopids present in the citrus orchards occurred in a distinctive pattern throughout the year, with the greatest number of adults over the period of summer (41%).

The minimum and average temperatures were the factors which had the greatest influence on the catches of *Ch. externa* adults. A correlation coefficient of –0.61 was found for the minimum temperature and of –0.52 for the average temperature (Fig. 3). The values of the coefficients showed that the fluctuations in the number of *Ch. externa* adults were due especially to the effects of the minimum and average temperatures, with the reduction in these factors producing a significant increase in the number of adults in the area studied.

Similar results were obtained by LARA *et al.* (1977) who determined a significant correlation between the minimum temperature and an increase in the number of adults of *Chrysopa* sp. caught under conditions of lowest minimum temperature

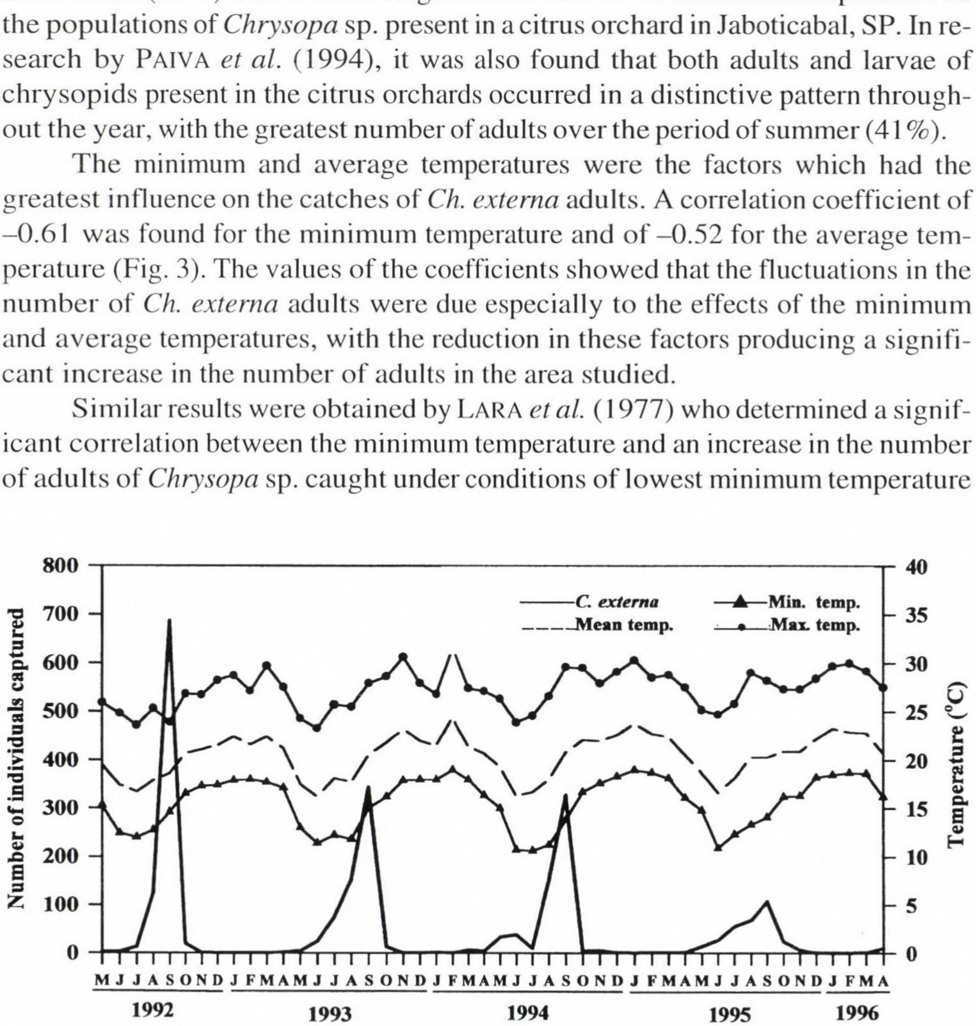


Fig. 3. Population dynamics of *Chrysoperla externa* adults over the period of May/1992 to April/1996 on citrus in relation to temperature. Lavras – MG, Brazil

(mean 13.3°C) which took place in the months from July to September 1974, in Jaboticabal, São Paulo.

The correlation coefficient obtained for precipitation, relative humidity and maximum temperature showed a similarity in the intensity of their effects upon the population densities of adults of *Ch. externa*. Conditions of low precipitation, low relative humidity and moderate maximum temperature, which are typical during winter in the region of Lavras, caused less effect on the population increase which occurred in the coldest and driest periods in contrast to the more dramatic effect caused by the minimum and average temperatures. Likewise, the reduction of their populations in the rainy and hottest seasons, typical of the summertime, was not due, primarily, to increased precipitation and increase of the relative humidity and maximum temperature, but rather to the increase of the minimum and average temperatures.

The greatest effect of temperature, especially of the minimum, on the *Ch. externa* populations, demonstrated their greater sensitivity to these conditions, within the thermal range found during the study period. Such conditions favored the population increase of adults, which occurred in greater number in the winter season. The pattern of population dynamics presented by this chrysopid differed from those found for most of the other groups of arthropods in tropical and temperate regions, which generally show population increases over the rainy and hot season (LEVINGS & WINDSOR 1990). This seasonal behavior of populations of *Ch. externa* adults may have occurred due to their best adaptation to the climatic variations to which normally they are submitted. These variations are characterized by well-defined summer and winter seasons, but not marked by such extreme and rigorous conditions as occurs in the temperate regions.

Adults of *Ch. externa*, when submitted to constant thermal conditions (15, 27 and 30°C) had their population density affected negatively (FIGUEIRA 1998, MAIA 1998). According to CAMMEL and KNIGHT (1992), the data related to insect biology, obtained at constant temperatures, may cause certain errors when extrapolated to a natural environment, where the thermal conditions are oscillatory. Under relatively low average temperatures, the developmental rate will be greater under oscillatory thermal conditions than under constant conditions, the effect of which on insect biology will be greater under larger variations of the diurnal temperature. Thus, the thermal oscillations occurring in field conditions, especially in the period of winter, may be of vital importance for the development of *Ch. externa*. These results may be compared to those obtained by GOUVEIA *et al.* (1996b), which showed the high sensitivity of chrysopids to temperature variations, suffering great changes in their population density when submitted to relatively small thermal variations.

In the northern hemisphere, the months from April to September, corresponding to the spring and summer seasons, are in general the most favorable to the development of insects of the order Neuroptera (JUBB & MASTELLER 1977, NEUENSCHWANDER & MICHELAKIS 1980, HONĚK & KRAUS 1981, CAMPOS 1989, MARÍN & MONSERRAT 1991). A significant increase in the chrysopid population in August and September was documented by ZELENÝ (1984) in the Czech Republic. Likewise, in Rumania, PAULIAN (1996) found a variation in the population of chrysopids captured in light traps in terms of the time of the year, recording a greater occurrence during summertime when over 90% of the total were captured.

In Praha-Ruzyně, Czech Republic, HONĚK and KRAUS (1981) documented significant correlation between adult *Ch. carnea* catches in light traps and temperature, wind velocity, precipitation and cloud amount. Precipitation showed a negative effect on the *Ch. carnea* captured, resembling, therefore, the results obtained for *Ch. externa* here reported. However, opposite to the results here reported, they found that an increase of temperature positively influenced the population density of that species.

The divergence between the results obtained for those chrysopids of the northern hemisphere and *Ch. externa* in relation to the effects of temperature, namely, the finding that higher temperatures have provided an increased number of insects captured in the north, may be due to thermal conditions during the winter which are characterized by extremely low temperatures unfavorable to their development. Increased temperatures during the summertime favored the catch, bringing about a negative correlation between those two factors, adversely to what was shown for *Ch. externa*.

The regression analysis of the total of *Ch. externa* adults captured weekly in the four years evaluated in terms of the weather factors (number of adults = β_0 + + β_1 × precipitation + β_2 × relative humidity + β_3 × temperature + ε) was significant ($P \leq 0.01$). The factor precipitation did not influence the number of adults ($P > 0.05$); but, the fit of the equation obtained was relatively low ($R^2 = 0.106$), indicating that the linear model used was not suitable to explain the joint effect of those factors on the changes in the size of the adult populations of this chrysopid. Thus, other models may be more adequate for furnishing the best fit.

Although, an increase in the number caught has been found in the coldest and driest period of each year, in general, its occurrence was observed though out the study period. Hence, there are times in which the weather conditions allow its survival, but they are unfavorable to its growth, development and reproduction. According to CAMMEL and KNIGHT (1992) insect species may response differently to

those conditions through physiological and behavioral changes capable of keeping them in their own habitat or to cause their spread to more favorable locals.

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SEASONAL FLIGHT PATTERNS OF ANTLIONS (NEUROPTERA, MYRMELEONTIDAE) MONITORED BY THE HUNGARIAN LIGHT TRAP NETWORK

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Few investigations have been conducted which characterise seasonal flight patterns of antlions, because of their usual small population size, sporadic and local occurrence, and sampling difficulties. Night-active myrmeleontids are attracted to light sources, so light trapping can collect them. The authors have monitored the seasonal flight activity patterns of nine antlion species over more than 20 years using regular nightly operation of the 60 light traps of the Hungarian light trap network.

Generally, the seasonal activity of adult antlions lasted from early May to the end of September, and mass flight occurred in the period early June–late August. Time series analytical methods detected three characteristic species-groups with different seasonal flight-types. The three groups were: (a) earlier active "late spring-early summer" flying antlions (*Megistopus flavicornis, Myrmeleon formicarius, Nohoveus punctulatus*); (b) intermediate "early and mid-summer" flying antlions (*Distoleon tetragrammicus, Myrmeleon inconspicuus, Myrmecaelurus trigrammus*); (c) later "mid- and late summer" flying antlions (*Creoleon plumbeus, Euroleon nostras, Acanthaclisis occitanica*). Within groups the flight patterns were synchronised. One to four 10–day interval temporal separations were found between general activity patterns of groups. Further studies are needed to understand the ecological background to the differences between the seasonal flights of myrmeleontid species.

Key words: Myrmeleontidae, antlion adults, flight activity pattern, seasonality, temporal separation

INTRODUCTION

Imagines and larvae of antlions are predatory insects possessing natural protective value because of their unique larval foraging strategies (obligate and facultative pitmakers vs. non-pitmakers), rarity of certain species, and their aesthetic values. Antlion larvae are generalist predators. Like spiders they have a top-predator function in insect food chains on the ground surface, especially in habitats where they are represented at high density. Only few studies have described or analysed the seasonal flight patterns of myrmeleontid species (*e.g.* from Europe: CURTO & PANTALEONI 1987; from Australia: MACKEY 1988; from the Afrotropical region: HÖLZEL & OHM 1990, GÜSTEN 2001), because of their usually smaller population size, temporally sporadic and locally restricted occurrences, and practical difficulties of long-term sampling. Consequently, in order to recognise seasonality of

adults, long-term, year-to-year monitoring programs with automatic collecting methods are necessary. European myrmeleontid species have positive phototaxis, so light trapping is one of the best methods for regular sampling of myrmeleontid adults. In Hungary, an extended light trap network (some 60 light trap stations at agricultural and forest habitats) has been in operation since 1958. Over seasons, daily operation of these traps offers a splendid chance to study population and assemblage level changes and trends of these insects at different time (daily – seasonal – long-term) and spatial (local – regional – countrywide) scales. In this study, the authors present and analyse the long-term data-series on the seasonal flight activity of adult antlions collected by this Hungarian light trap network.

The aims of this study

(1) To produce the general seasonal flight activity pattern of the selected myrmeleontid species based on long-term light trapping data.

(2) To describe and characterise the flight patterns of various antlion species (start, peak, and end of flight, mass flight period, length of seasonal activity, modality of seasonal activity distribution).

(3) To compare flight patterns of different myrmeleontid species in order to describe synchrony level between them.

(4) To find any characteristic antlion groups formed by similar seasonal flight patterns.

MATERIAL AND METHODS

Collecting method: light trapping

The Jermy-type trap applied in the Hungarian network has operated without baffles, using a white light source (100 Watt, tungsten filament bulb in all agricultural and some forestry traps; or 125 W mercury vapour bulb at other forestry trap sites). The light source is at a 2–metre height above the ground. Capture rate of adult antlions with light traps is usually smaller because of their lower flying speed, stronger stenotopy and lesser density. To achieve satisfying flying data on even more myrmeleontid species of a typical habitat, an experimental Minnesota-type light trap (100 W, normal white light) has been set up on a protected sand dune area near Fülöpháza in Kiskunság National Park. Capture effectiveness of this trap type is considerably greater, because it has three baffles around the light source.

Trapping sites

The stations of the regular ligth trap network were scattered in agricultural habitats such as orchards, vineyards, arable fields, parks, etc and in various forest types such as oak, beech, pine, etc. In addition to the trap on the sand dune, flight-data of adult antlions were produced in 39 agricultural and 20 forestry trap sites, respectively.

Timing and frequency of samplings

The antlion adults were identified from samples collected in agricultural areas between 1981 and 1995, and in forested habitats between 1977–1983, and since 1991. Light traps have collected flying insects each night in the period from the beginning of March or April to the end of October.

Selected myrmeleontid species

Seasonal flight characteristics of only nine myrmeleontid species could be studied. Only the following species were represented by sufficient individuals (at least 20 specimens): *Megistopus flavicornis* (ROSSI, 1790); *Distoleon tetragrammicus* (FABRICIUS, 1798); *Myrmeleon inconspicuus* RAMBUR, 1842; *Myrmeleon formicarius* LINNAEUS, 1767; *Euroleon nostras* (FOURCROY, 1785); *Myrmecaelurus trigrammus* (PALLAS, 1781); *Nohoveus punctulatus* (STEVEN, 1822) (= *Myrmecaelurus zigan* ASPÖCK, ASPÖCK et HÖLZEL, 1980); *Creoleon plumbeus* (OLIVIER, 1811); *Acanthaclisis occitanica* (VILLERS, 1789).

Data processing and statistical analyses

To produce the mean seasonal flight-patterns for the analyses, the nightly catches were summed within ten-night intervals over the season in each year. These 10-day units were counted from 1st of June forward and back in order to decrease the shifts in months caused by 31st day of May, July, and August. From all of years, catches of the same 10-day intervals were summarised and averaged. From these averaged data the seasonal distribution (%) of individuals captured per 10-day intervals was calculated for each antlion species. The latter distributions were used as the species-characteristic seasonal flight activity pattern. For assessment of interspecific synchronies (overlaps) between seasonal activity patterns, a time series analytical method, the cross correlation function (CCF) was applied (SZENTKIRÁLYI 1997, KÁDÁR & SZENTKIRÁLYI 1998). The CCF values were calculated using shifts with different number of 10–day intervals between the two seasonal activity patterns. Table 1 shows the maximal significant CCF values (r) at 95% confidence level, and the number of corresponding 10–day intervals as lags. Using this method, the lower the number of lags attached with a maximal significant r values, the greater the synchrony between two patterns compared. For similarity analysis we used more clustering methods that produced the same result. Therefore only one of them is presented in Fig. 7.

RESULTS AND DISCUSSION

In the Central European region, myrmeleontid assemblages with the greatest species-richness and population size can be found on the extended sandy area between the rivers Danube and Tisza in Hungary (GEPP & HÖLZEL 1989). Thus, monitoring must be considered to be important in their protection. Hungarian representatives of antlions are all attracted to light, and so light trapping can catch them. The majority of existing faunistic data on Hungarian antlions also came from light trapping network (STEINMANN 1963). So far 15 species have been recorded in Hungary (SZIRÁKI *et al.* 1992). However, this total includes single examples of 3 rare immigrant or vagrant species, not known to breed in Hungary and thus not considered a part of the Hungarian fauna, which is comprised of the remaining 12 antlion species. There are scattered references in earlier Hungarian literature on seasonal occurrence and flight period of antlion imagines (BÍRÓ 1885, STEINMANN 1963), but most of these refer only to the date of records and do not include detailed phenological analysis. It is understandable, since regular data collecting could start with setting up the light trap network.

Properties characterising adult antlions like stenotopy (they rarely fly outside of their biotope), low vagility level (they fly slowly and relatively weakly), low population density for several species, sporadic flight activity all contribute to the low number of captures at light traps.

Nevertheless, today there are collecting data series from several years for this group of insects, though the majority of light traps did not operate in typical antlion habitats, and so the local seasonal patterns are not represented well by these data. Therefore, a general flight pattern was attained only by superposing data. Thus in the present study, the constructed seasonal flight-activity patterns refer to a countrywide spatial-scale and a seasonal time-scale containing a mean of between-year and between-site variations.

In years and sites of our study, a total of 11 antlion species were captured at light traps, of which two were represented by only 1–2 individuals (*Neuroleon nemausiensis* BORKHAUSEN, 1791, *Dendroleon pantherinus* FABRICIUS, 1787) and were excluded from seasonality analyses. The remaining 9 species belong to the more common species of antlions in Hungary, most of which are abundant in appropriate habitat.

Characteristics of seasonal flight activity patterns

Generalised seasonality patterns of each antlion species are shown in figures 1–3, and seasonal frequency distributions of the start and end of flight are represented in Figs 4–6. Species exhibiting flight at the same period and expressing sim-

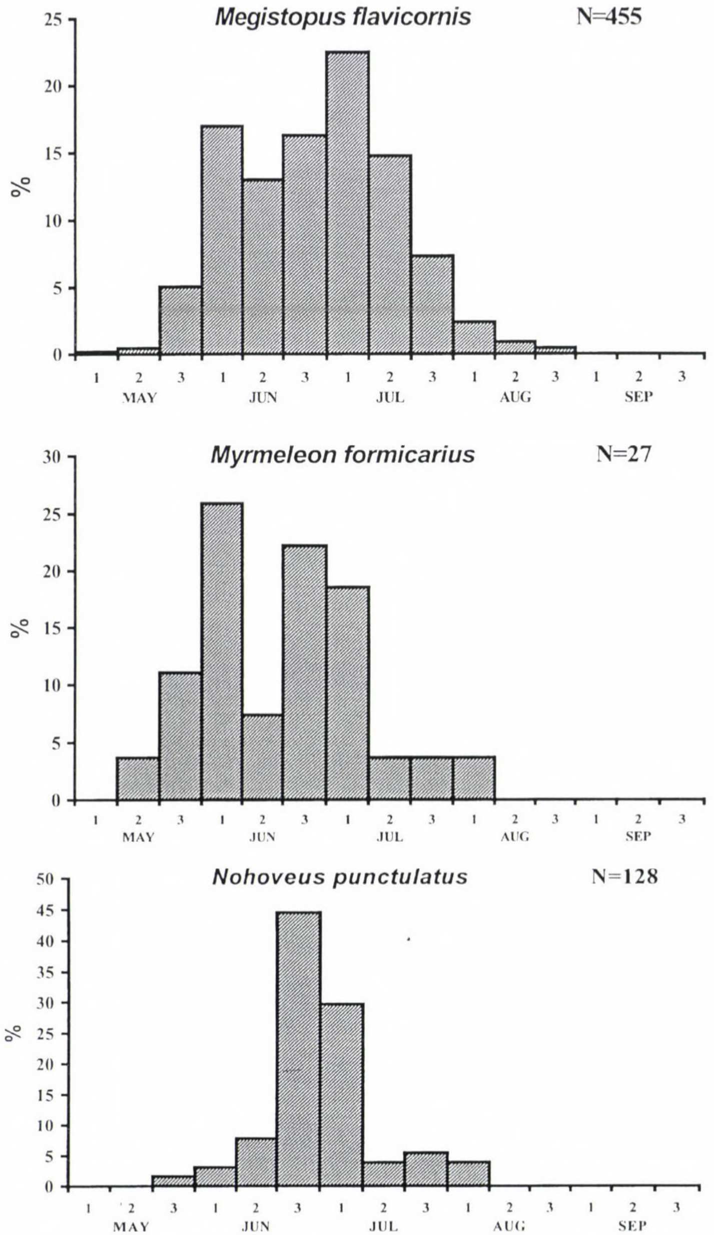


Fig. 1. Seasonal flight pattern of "late spring-early summer" active myrmeleontid species based on long-term collections of the light trap network in Hungary. (*Y-axis*: percent rates of mean number of individuals caught during the same ten-day periods over the monitoring years; N: total number of individuals)

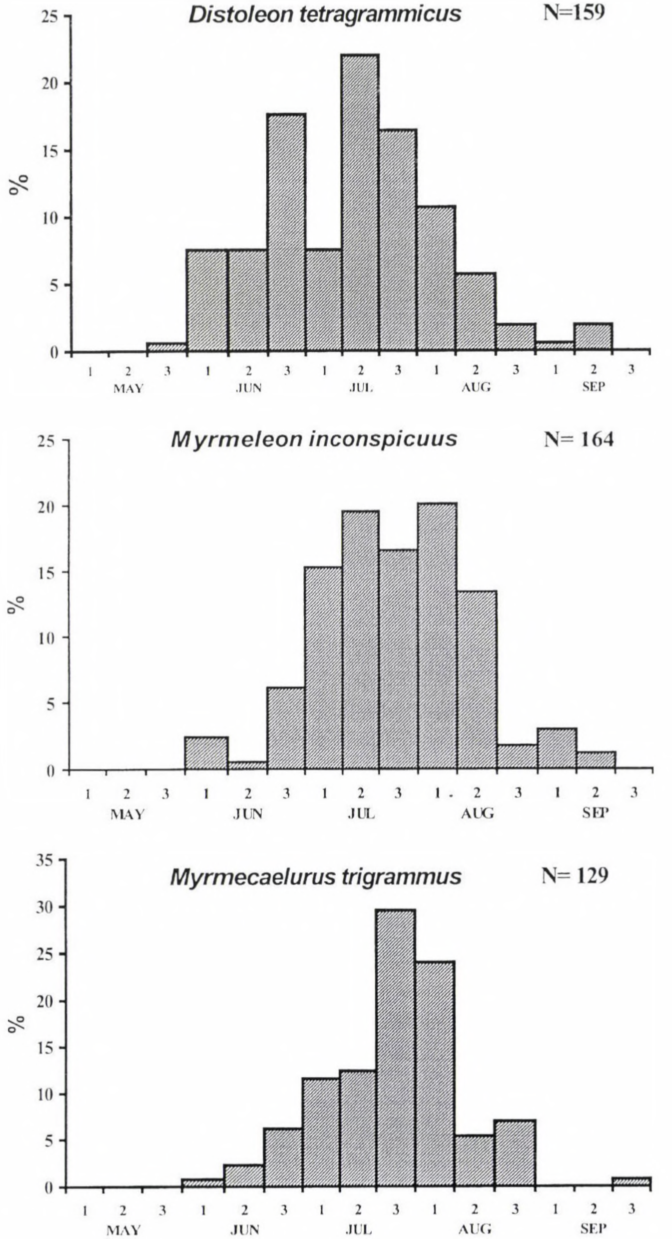


Fig. 2. Seasonal flight pattern of "early and mid-summer" active myrmeleontid species based on long-term collections of the light trap network in Hungary. (*Y-axis*: percent rates of mean number of individuals caught during the same ten-day periods over the monitoring years; N: total number of individuals)

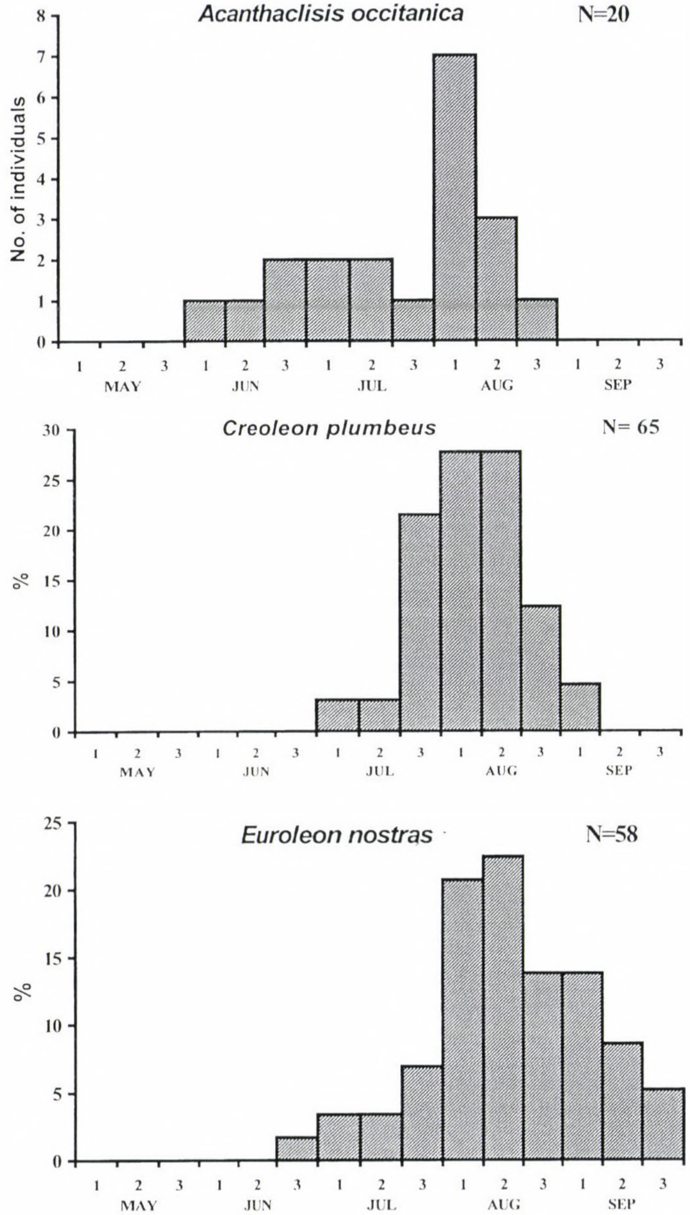


Fig. 3. Seasonal flight pattern of "mid- and late summer" active myrmeleontid species based on long-term collections of the light trap network in Hungary. (*Y-axis*: percent rates of mean number of individuals caught during the same ten-day periods over the monitoring years; the pattern of *A. occitanica* is given in individuals because of the low number of catches; N: total number of individuals)

ilar seasonality are shown in sequence, so the antlions with the earliest swarming are in Fig. 1 and latest ones are in Fig. 3. The same rank is used in Figs 4–6.

M. flavicornis – This species, one of the antlions with the earliest seasonal flights, proved to be the most dominant in light trap samples (Fig. 1). Its flight lasts

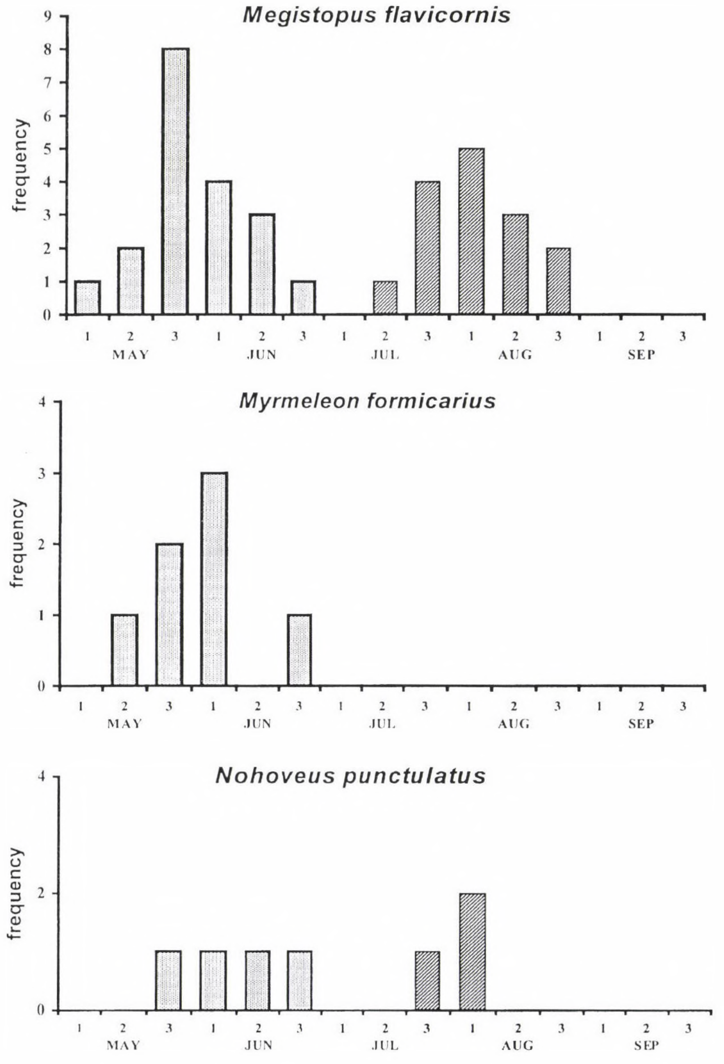


Fig. 4. Seasonal frequency distribution of the start (pointed columns) and end (striped columns) of yearly mean flight showed by "late spring-early summer" active myrmeleontid species, data based on collection of Hungarian light trap network

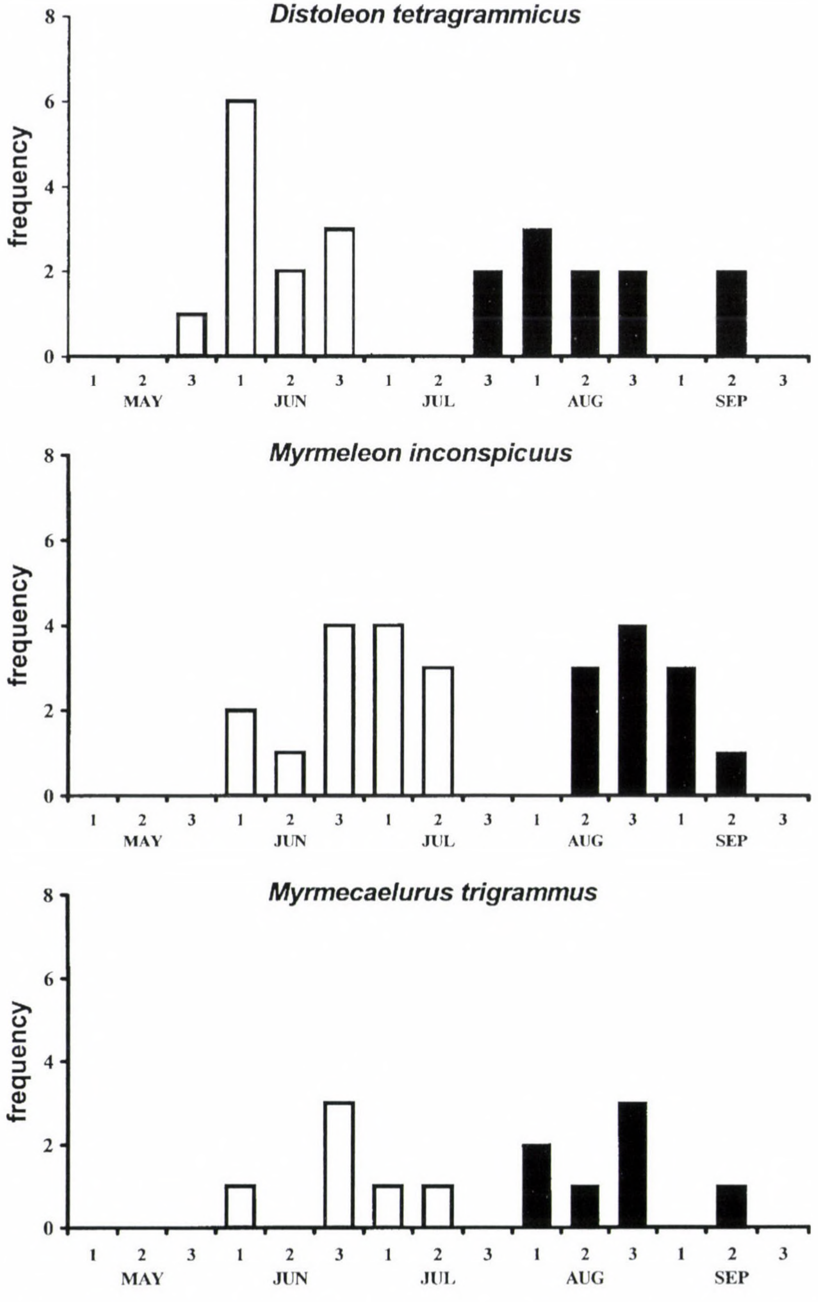


Fig. 5. Seasonal frequency distribution of the start (empty columns) and end (black columns) of flight showed by "early and mid-summer" active myrmeleontid species, data based on collection of Hungarian light trap network

from the beginning of May to the end of August. Mass flight period is allocated between the beginning June and the second ten-day period in July, with a smaller peak in early June and with a greater activity peak in early July. Such a bimodal seasonal flight-activity distribution was also expressed by *M. formicarius*, *D. tetragrammicus*, and to a lesser degree by *M. trigrammus* and *A. occitanica*. The explanation of this bimodality can be found in the phenomenon of protandry, except for *N. punctulatus* and to a certain extent *C. plumbeus* as well. The protandry is known in case of antlions. For example, in *M. bore*, *M. formicarius* and *E. nostras* it is also reported by LÖFQUIST and BERGSTRÖM (1980) and YASSERI and PARZEFALL (1996). Studying seasonal sex distribution in recent study, males emerged and flew 1–3 ten-day periods earlier than females, depending on the given species. This time lag between flights of males and females can give the first seasonal peak in number of individuals when males are still strongly active and females start to fly. Later, activity of high number of females added to still active males build up the second, usually greater peak. Seasonal activity patterns of sexes and detailed analysis of local and annual variations of these will be covered in another article.

Flight in *M. flavicornis* starts most probably in the last third of May–early June and declines at the end of July–beginning of August (Fig. 4). STEINMANN's (1963) data support the above seasonality characteristics, which suggest that imagines fly from early May to late August, and the highest frequency of this activity is during June in Hungary. BÍRÓ (1885) also mentioned records of this species only from May and early June.

M. formicarius – It occurred in captures at many light trap stations, however it was represented by only 1–2 specimens. Its seasonal activity (Fig. 1) ranges from mid-May to the first third of August; the mass flight is between early June and the first ten-day period of July. Flight pattern is bimodal, with two activity peaks in early and late June. STEINMANN's (1963) data reveal that adults of this species fly from mid-May to early August and the activity peak is formed in mid-June. Because of limited data, only the start of flight could be detected in several cases, these suggest that it takes place at the end of May and early June (Fig. 4).

N. punctulatus – Within its forest steppe belt area, this Mongol-eremial fauna element has its most western habitats in Europe on the Hungarian sand dunes. A light trap set up in such a dune (Fülöpháza) provided most of its data. *N. punctulatus* belongs to antlions with shorter flight-period. Its flight lasts from the end of May to late August. Mass flight occurs in a short, 20-day period, which is also coincident with the activity peak in the last ten-day period of June. STEINMANN's records absolutely support all the characteristics presented here.

The beginning of flight of *N. punctulatus* (Fig. 4) varies between the end of May and late June and it is finished most probably in the first ten-day unit of August.

D. tetragrammicus – This species has a wider seasonal activity (Fig. 2), flying from the end of May to mid-September. The pattern shows a considerable activity level between early June and early August with late June and mid-July peaks. Flight of this species starts during June (mainly at the beginning) and most probably it ends in August (Fig. 5). STEINMANN's (1963) records of *D. tetragrammicus* indicate a seasonality of similar length: a period between early June and mid-September. Its mass flight occurs a bit later in his data however, between the end of July and mid-August. According to BÍRÓ (1885) this antlion flies usually in July.

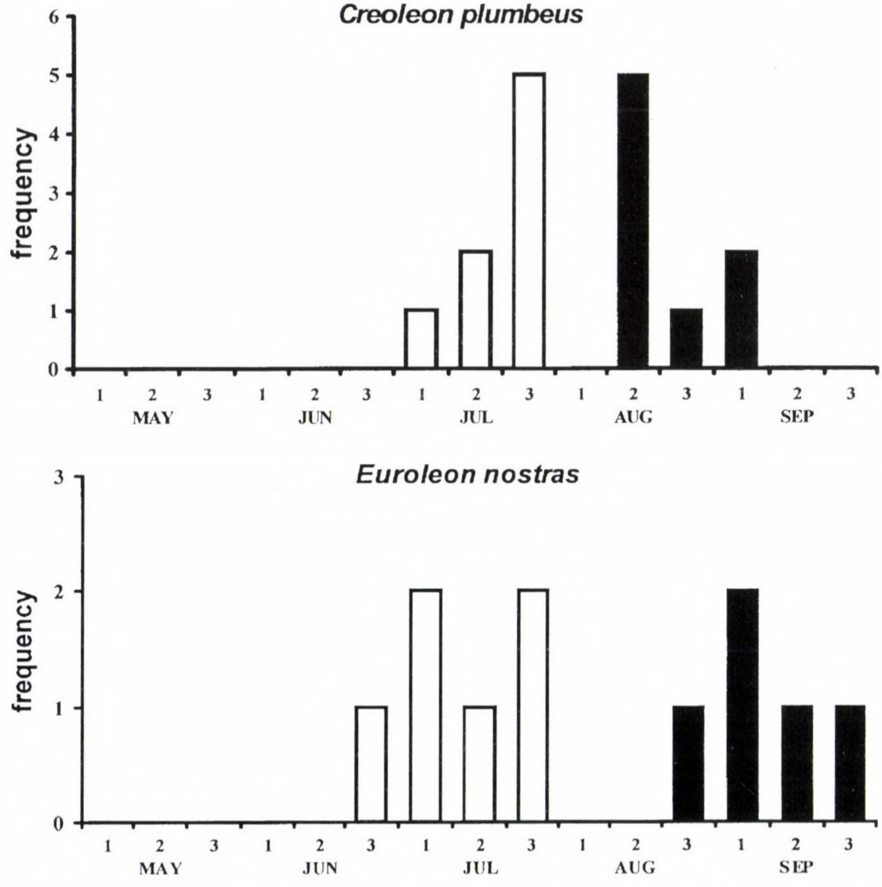


Fig. 6. Seasonal frequency distribution of the start (empty columns) and end (black columns) of flight showed by "mid- and late summer" active myrmeleontid species, data based on collection of Hungarian light trap network

M. inconspicuus – Flight activity lasts from the beginning of June to mid-September (Fig. 2), mass flight takes place from early July to mid-August. There is no definite activity peak; most individuals fly between mid-July and early August. Flight starts mainly at the end of June – early July and finishes in late August (Fig. 5). Most of records given by STEINMANN (1963) coincide with the above mass flight period that form a peak in early August. BÍRÓ (1885) stated that the flight of this species occurs in July.

M. trigrammus – The seasonal activity pattern is well distinguished from that of *N. punctulatus* (Fig. 2). Flight of *M. trigrammus* usually ranges from early June to late August, though certain individuals can be captured in September (see in Fig. 2) or even in October (STEINMANN, 1963). The more intensive flight period of imagines can be observed from the beginning of July to early August and is characterised with a sharp peak in the last ten-day interval of July. Flight often starts in late June and ends in late August (Fig. 5). According to STEINMANN's (1963) data this species is active from the end of June to early October, its major flight activity can be find in early and late July.

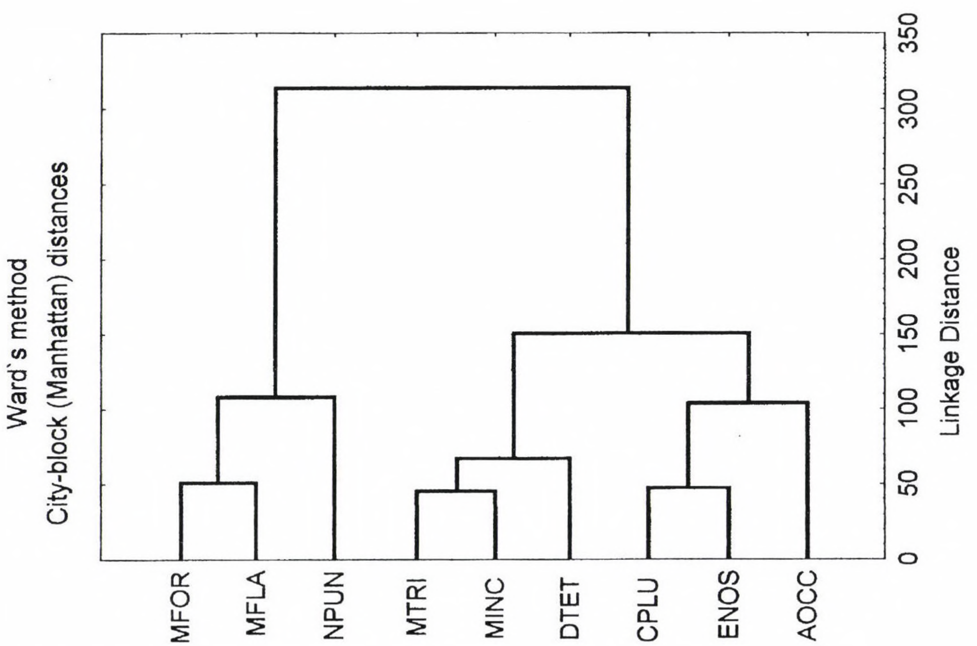


Fig. 7. Characteristic groups of antlion species with seasonally synchronised flight patterns. (The existence of three similarity groups was confirmed by various cluster analyses, e.g. Ward's method)

A. occitanica – Seasonal flight period expands between early June and the end of August (Fig. 3). Due to the low number of collected individuals, the mass flying period could not be detected, but it is likely to have an activity peak in the first ten-day period of August. Records published by STEINMANN (1963) support that it flies from early June till the end of August with an activity peak at the end of July. BÍRÓ (1885) also mentioned that adults of this antlion usually occur in August. In the case of *A. occitanica*, further light-trap samples are required in order to reveal the seasonal flight dynamics of imagines.

C. plumbeus – The flight pattern shows (Fig. 3) that this antlion belongs to those species that have a shorter seasonal activity. Imagines are active from early July to early September. Mass flight lasts from the third ten-day period of July to mid-August. The flight peak occurs in the first half of August. The start and end of flight are close to each other (Fig. 6): they are most frequent in late July and middle of August, respectively. Earlier records of STEINMANN (1963) and BÍRÓ (1885) support this phenology, mass flight of *C. plumbeus* given as between mid-July and mid-August, and peak activity taking place in the first ten-day period of August.

Table 1. Degree of temporal overlaps between seasonal flight patterns of myrmeleontid species

	MFLA	NPUN	MTRI	MINC	DTET	CPLU	ENOS	AOCC
MFOR	0 0.82	0 0.64	-3 0.71	-4 0.73	-2 0.82	-5 0.66	-6 n.s.	-4 0.67
MFLA		0 0.63	-2 0.77	-2 0.75	-1 0.81	-4 0.72	-4 0.59	-3 0.68
NPUN			-3 0.89	-2 0.69	-2 0.69	-4 0.66	-4 0.69	-4 0.82
MTRI				0 0.87	+1 0.84	-1 0.86	-1 0.79	-1 0.83
MINC					0 0.79	-1 0.89	-2 0.82	-1 0.61
DTET						-3 0.75	-2 0.62	-2 0.77
CPLU							0 0.85	+1 0.73
ENOS								0 0.66

Notes: numbers in cells: lags in 10-day intervals (upper numbers) at highest positive significant *r* values of CCF (lower numbers); The lagged seasonal patterns of antlion spp. are in columns; the greyish cells: comparisons between patterns within the same seasonality group

Abbreviations: MFOR= *Myrmeleon formicarius*, MFLA= *Megistopus flavicornis*, NPUN= *Nohoveus punctulatus*, MTRI= *Myrmecaelurus trigrammus*, MINC= *Myrmeleon inconspicuus*, DTET= *Distoleon tetragrammicus*, CPLU= *Creoleon plumbeus*, ENOS= *Euroleon nostras*

E. nostras – The seasonal activity pattern of this antlion species is shifted to the latest summer period. Imagines begin their flight in June, which lasts until the end of September (Fig. 3). Mass flight can be detected in the period from early August to early September with an activity peak in mid-August. Flight begins most frequently in July and it stops during September (Fig. 6). STEINMANN's (1963) data also show that this species flies mainly during August, and it is characterised with an activity peak in mid-August. Some individuals fly later, even in mid-October. BÍRÓ (1885) also noted one record of *E. nostras* found in September.

Level of interspecific synchrony between adult flight patterns

A look at the flight diagrams instantly illustrates that seasonal activities of all the antlion species studied are not synchronised with each other, some species fly earlier, others later, and so it seems that they can be categorised into flight-groups according to these characteristics. In order to analyse the rate of interspecific separation/overlap between seasonal activity patterns, the whole available light trap da-

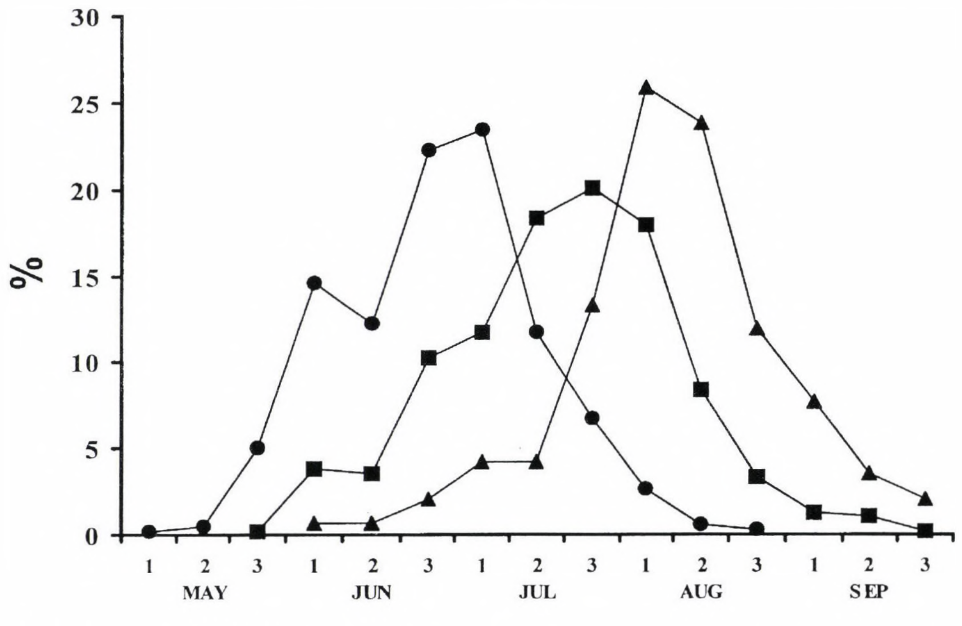


Fig. 8. Mean seasonal activity patterns of antlion groups with characteristic three flight-types based on collections of long-term monitoring light trap network in Hungary (●: "late spring-early summer" flight group *M. flavicornis, M. formicarius, N. punctulatus*; ■: "early and mid-summer" flight group *D. tetragrammicus, M. inconspicuus, M. trigrammus*; ▲: "mid- and late summer" flight group *A. occitanica, C. plumbeus, E. nostras*)

tabase was investigated using time series analysis. CCF functions were calculated and maximal significant *r* values with corresponding lags in number of ten-day periods were arranged in table (Table 1) by every possible comparison between pairs of species. Lag numbers indicate (regardless of the plus-minus sign) the degree of shift/separation in ten-day intervals between flight patterns of antlion species, reflecting the rate of synchrony. Data in Table 1 illustrate well that depending on different species, the values are ranged from total synchrony (no. of lags = 0) to 5–6 ten-day interval separation (a period of 1.5–2 months!). Arranging lag values it became clear that flight patterns of certain species were similar and synchronised with each other (0 lag), while they were more or less separated from others (2–6 lags).

Detection of characteristic groups of seasonal flight-patterns

In order to show from former results the expected groups gathering species with identical seasonality, cluster analyses were carried out involving various similarity methods. All the similarity analyses used on patterns of the 9 species confirmed the existence of the same 3 characteristic flight groups (Fig. 7): a well-separated earlier active antlion group (*M. flavicornis*, *M. formicarius*, *N. punctulatus*), and two more or less overlapping groups with later seasonal activity. The latter two groups consist of the species triplets *D. tetragrammicus*, *M. inconspicuus*, *M. trigrammus* and *A. occitanica*, *C. plumbeus*, *E. nostras*. Within these three seasonality groups, flight patterns are well synchronised between species (see in Table 1 the greyish cells with lag = zero or 1).

General seasonal patterns of characteristic flight groups of antlions

Table 1 shows flight activity pattern of characteristic flight groups, calculated from the total light trap catches of antlions belonging to each indicated groups. The separation of the seasonal activity patterns of the three groups and the partial overlap between them can be easily observed. According to this, the following seasonality is characteristic of the three groups.

A – The earliest active is the *M. flavicornis*, *M. formicarius*, *N. punctulatus* group with a "late spring – early summer" flight-type. Mass flight ranges from the beginning of June to mid-July with an activity peak at late June – early July.

B – Members of the "early and mid-summer" flight-type group: *D. tetragrammicus*, *M. inconspicuus*, *M. trigrammus*. Characteristic mass flight lasts from the beginning of July to early August, and the flight peak is allocated in the third ten-day period of July.

C – Group of "mid- and late summer" flight-type: *A. occitanica*, *C. plumbeus*, *E. nostras*. Main flight period of this group lasts from the end of July to late August/early September.

There is a mean lag of 2–3 ten-day periods between flight patterns of group (A) and (B), while the rate of separation between group (A) and (C) is a lag of 3–5 ten-day periods (Table 1). The lag between patterns of group (B) and (C) is usually 1–2 ten-day period. It seems that depending on latitude, there is a geographical variation in the seasonal allocation of emergence and flight periods of the same myrmeleontid species. In northern latitudes in Europe (*e.g.* LÖFQUIST & BERGSTRÖM 1980, YASSERI & PARZEFALL 1996) adults of *M. formicarius* emerge later (in July), while *E. nostras* adults emerge earlier (mainly in July) than in Hungary at more southern latitudes.

Other phenological analyses from literature also suggest that it is possible to have a shift between main flight periods of different antlion species at the same habitat. Within European antlions, CURTO and PANTALEONI (1987) in southern Italy found such partial time separation between seasonal activities. According to their published activity diagram, flight peaks of antlion species *Creoleon lugdunensis* VILLERS, *Macronemurus appendiculatus* (LATREILLE) and *Neuroleon egenus* NAVÁS followed each other in this order with a 2-week lag. This time-lag period caused an easily detectable separation in both of the start and end of flights. MACKEY (1988) in Australia (Queensland) monitored with light traps for 7 years, and recorded 13 myrmeleontid species. Although individuals of the observed antlion species occurred very sporadically over the whole year, there was a tendency that flight activity level increased in certain periods of the season (October–November and February–March). MACKEY (1988) thought that these increases in abundance indicate 1 or 2 possible annual generations, but he does not deny the chance that these are related to a longer emergence period and long adult life. HÖLZEL and OHM (1990) on Cape Verde Island reported on the seasonal activity distribution of some antlion species collected with light traps. Reviewing their data, there can be detected a noticeable tendency between the flight peaks to shift from each other. In Tunisia, North Africa, GÜSTEN (2002) carried out detailed collections of antlions with portable light traps. On the basis of his records, he detected that antlions had seasonality, certain species expressed early-season flight activity, while others were characterised with late-season activity. Early-season species were *Maracanda lineata* NAVÁS and *Macronemurus elegantulus* MCLACHLAN, while *Geyria saharica* ESBEN-PETERSEN and *Acanthaclisis occitanica* were listed among late-season antlions.

So far, the factors reasonable for partial separation between seasonal flight activity patterns of the studied Hungarian antlion groups are not known. It is unlikely that alternative foraging strategies of larvae (there are pitmakers and non-pitmakers in all the three groups), or variability of developmental period (in each groups there are species with 1 or 2 years of developmental period), or changes in size of body (smaller or larger bodied imagines are among the members of each groups) or possible competitions might explain the seasonal separations between the certain groups of antlions. In the future, the responsible factors and ecological consequences of this phenomenon should be investigated.

CONCLUSIONS

The general length of seasonal activity of antlions lasted from early May to the end of September. The mass flight of studied antlions fell into the period of early June – late August, while the start and end of flight ranged from early May to late July and from mid-July to late September, respectively. These seasonal characteristics showed between-year and species-specific variations (Figs 1–6).

Although the overlapping of the whole seasonal flight patterns of antlions are significant, there are certain separations between the species depending on temporal allocation of mass flight period and flight peaks. The shorter (*N. punctulatus, C. plumbeus*) or longer (*e.g. D. tetragrammicus, M. inconspicuus, M. flavicornis*) length of seasonal activities may reflect a shorter or longer emergence period or adult life span.

On basis of statistical analyses (Figs 7–8, Table 1) the studied adult myrmeleontids belong to three flight-types forming species groups with different seasonal activity pattern. These three groups are: (a) earlier flying group [EF] with "late spring–early summer" flight pattern *M. flavicornis, M. formicarius, N. punctulatus*; (b) intermediate flying group [MF] with "early and mid-summer" flight pattern *D. tetragrammicus, M. inconspicuus, M. trigrammus*; (c) late flying group [LF] with "mid and late summer" flight pattern *C. plumbeus, E. nostras, A. occitanica*.

Within these groups, the flight-activity patterns between the species were closely synchronised (Table 1), while the between-group comparisons detected lags with 1 to 6 ten-day intervals between the seasonal activities. The separation in the generalised flight patterns (Fig. 8.) were 2 ten-day intervals between [EF] & [MF], 4 ten-day intervals between [EF] & [LF], and 1 or 2 ten-day intervals between [MF] & [LF].

Similar separation was found between seasonal activity patterns of other European and tropical/subtropical antlion species. Further investigations are necessary for the ecological background to explain the seasonal differences between the flight patterns.

*

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LACEWINGS AND SNAKEFLIES (NEUROPTERA, RAPHIDIOPTERA) AS PREY FOR BIRD NESTLINGS IN SLOVAKIAN FOREST HABITATS

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Songbirds in their breeding period are among the most important predators of neuropteroid insects. The second author has conducted a long-term study on diet of 40 species of songbirds in the nestling period (May–July) since 1978 in mountainous oak-hornbeam, beech-oak, and beech-coniferous forests in Central Slovakia. More than 60,000 food items were collected predominantly by the neck-ring method and to a lesser extent by pellet, stomach, and dropping content analysis. The proportion of Neuroptera and Raphidioptera in food of nestlings of 17 bird species ranged between 0.1–3.9% and 0.1–4.4%, respectively.
Among the 4 raphidiid, 7 chrysopid, and 5 hemerobiid species recorded in diets, the most abundant were *Dichrostigma flavipes* (adults), *Nineta pallida* (larvae), and *Hemerobius micans* (adults). The chrysopids were present with the greatest dominance (59%) in the food composition of foliage gleaners, while hemerobiids were captured in higher proportions (50%) by bark foragers. The raphidiids were collected mainly by the generalist *Ficedula albicollis* (61%), and by bark foragers (36%). In the diet composition of ground foragers only a low number of neuropteroids were present. The sampled birds caught the highest number of individuals from the three families of neuropteroids in the period between mid-May and early June.

Key words: Neuroptera, Raphidioptera, Chrysopidae, Hemerobiidae, Raphidiidae, songbirds, food of nestlings, foraging mode

INTRODUCTION

In their breeding period, the songbirds may be among the most important predators of neuropteroid insects. According to the numerous data published in the world literature, the proportion of neuropteroid insects in the food composition of birds ranged between 0.4–4.0% (mean: 0.95%) in agricultural habitats, and 0.1–12.0% (mean: 3.5%) in forests. These values show that neuropteroid insects are frequently found with much higher rates among the prey of songbirds than with which (<1%) they are usually represented in insect assemblages of their habitats. Contrary to the many studies on feeding and food preference of birds, only a few lacewings and snakeflies were identified at species level among prey of birds (BETTS 1956, 4 chrysopids; KOŽENÁ 1975, 1 chrysopid, 2 hemerobiids, and 1

raphidiid; SZENTKIRÁLYI and TÖRÖK 1983, 7 chrysopids, 6 hemerobiids, and 4 raphidiids; BUREŠ 1986, 1 hemerobiid, 3 raphidiids). During the last twenty years, the second author has carried out a long-term study on the diet of 40 songbird species in the nestling period in central Slovakian forests. He found that the songbirds can feed on a large amount of homopteran insects (mainly aphids and psyllids) and numerous aphidophagous coccinellids and syrphids (KRIŠTÍN 1988, 1991). Recent study relates to the identification and data analysis of the chrysopids, hemerobiids, and raphidiids captured by birds in central Slovakian mixed forests over 17 years.

The aims of this study

(1) To identify which songbirds captured which neuropteroid species during their breeding period.

(2) To show the extent to which the neuropteroid species composition in the food of birds corresponds to the expected one in the given forest habitats.

(3) To analyse the variation in the proportion of neuropteroid prey groups in relation to the foraging mode (hunting style) of bird species.

(4) To describe the seasonal distribution of the prey neuropteroid families in the diets of nestling.

MATERIAL AND METHODS

Collecting methods

The food samples were taken predominantly by a modified neck-ring method (93.2%). In smaller quantity, pellet and stomach analysis (3.2%), and dropping analysis (3.6%) were also used. The collars around the neck were applied to 3–15 days old bird nestlings. Collection of food samples from birds was carried out between 7^{h} and 18^{h} during the nestling period of May, June, and July. A sampling unit means all food (arthropod) items captured by the bird parents during a 2-hour time period. All types of food samples were preserved till examination in 75% alcohol. The numbers of sample units and arthropod food items per studied birds are presented in Table 1.

Sampling sites and periods

The investigations were conducted in the central Slovakian mountains Kremnické Vrchy. The samples were collected in three localities of this mountainous area in oak-hornbeam, beech-oak, and beech-coniferous mixed forests scattered with xerothermous habitat patches, as follows:

Kováčová valley near Zvolen (19°06'E, 48°38'N), SW–SE slope, between 400–530 m a.s.l. Vegetation comprised by relatively homogeneous, 20 ha sized, 80–100 years old stands of *Querco–Fagetum* (80%) and *Fageto–Quercetum* (20%) forest associations. In the vicinity there was also a forest of *Fagetum–Carici pilosae* mixed with coniferous tree (spruce, fir) stands.

Stráže-mountain, near Zvolen (19°07'E, 48°34'N), 380–440 m a.s.l. The vegetion type was oak-hornbeam mixed forest association, *Carpinenion betuli–Carici pilosae.*

Polána-mountain, near Zvolen (19°08'E, 48°35'N), 1300 m a.s.l. The vegetation type was *Sorbeto–Piceetum.*

Food material was sampled over the years between 1978 and 1994, during the period May–July.

Bird species studied

A. KRIŠTÍN has studied feeding ecology of 40 European songbird species (Passeriformes, Piciformes, and Coraciiformes). After examination of more than 60,000 food items collected by adult birds in breeding periods, neuropteroid insects were found in diets of 17 bird species (see in Table 1). Only 11 bird species produced higher number of neuropteroid food items in sufficient condition for taxonomic identification. They are as it follows *Certhia familiaris* (Tree Creeper), *Dendrocopos major* (Great Spotted Woodpecker), *Erithacus rubecula* (Robin), *Ficedula albicollis* (Collared Flycatcher), *Fringilla coelebs* (Chaffinch), *Parus ater* (Coal Tit), *Parus major* (Great Tit), *Phylloscopus collybita* (Chiffchaff), *Phylloscopus sibilatrix* (Wood Warbler), *Prunella modularis* (Dunnock), *Sitta europaea* (Nuthatch). The foraging modes of these birds are given in Table 1–2.

Data evaluation

Percentage proportion of each arthropod order in the diet of nestlings was calculated for total samples for each studied bird species (Table 1). Proportions of Neuroptera, (Chrysopidae, Hemerobiidae), Raphidioptera and potential prey of these groups (Homoptera: aphids and psyllids) are shown in Table 1. Bird species are grouped according to their prey foraging mode (hunting style): foliage gleaners, bark foragers, ground foragers, and feeding generalists. The neuropteroid prey-species of the members of these foraging groups are presented on Table 2. Table 3 shows the ecological characteristics, dominance (D%) of individual numbers, and percentage ratio of neuropteroid species found in the diet composition of nestlings arranged by foraging mode of the birds. The individual numbers of Chrysopidae, Hemerobiidae, Raphidiidae occurring in food items were summed within each family according to foraging modes. From these sums two kinds of percentage distribution were calculated: (a) distribution of individuals (as food items) of each neuropteroid family among the 4 diet-groups acquired with the 4 foraging modes; (b) distribution of the 3 neuropteroid prey families in the diet of bird group of each foraging mode, which reflect on a preference of birds to capture a certain family. Results are shown in Table 4. A temporal grouping has also been made on samples of the 3 neuropteroid families collected by birds. For this number of lacewing individuals was summarised both for adults and larvae in 10–day intervals over period of May–June. This seasonal distribution of families in bird food during the breeding period is illustrated in Fig. 1.

RESULTS AND DISCUSSION

Proportion of Neuroptera and Raphidioptera among arthropod food kinds of birds

After examination of more than 60,000 food items it turned out that neuropteroid insects were found only in nestling diets of 17 bird species. Arthro-

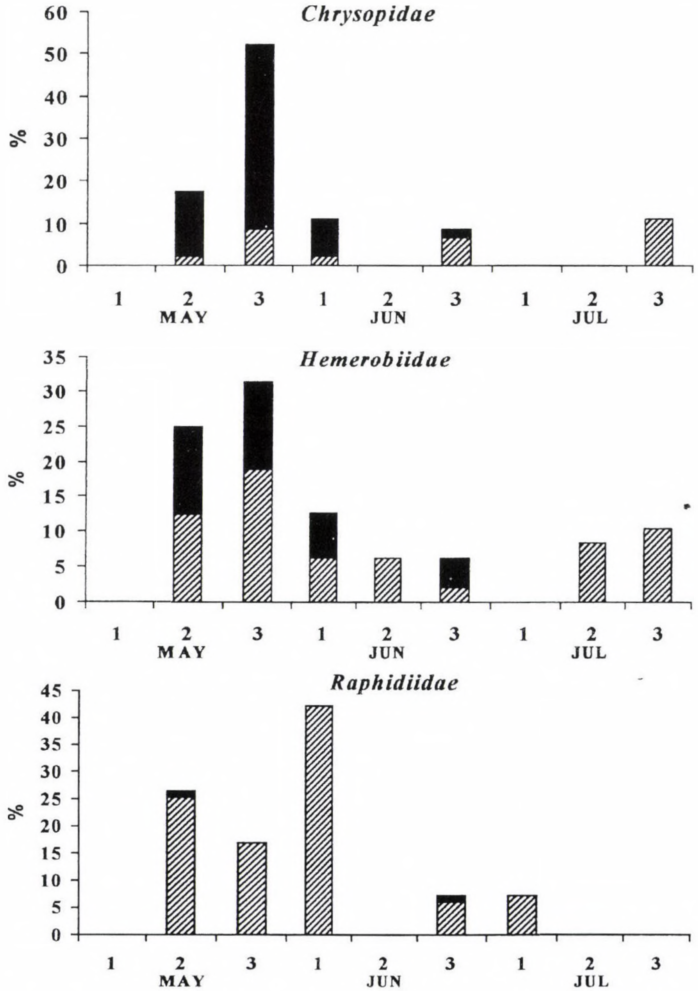


Fig. 1. Seasonal distribution (%) of neuropteroid insect families in the food of bird nestlings in central Slovakian forests collected over 1987–1993 (The data were calculated by the three 10-day periods per month. Black columns: percent of larvae, striped columns: percent of adults.)

Table 1. Proportion of Neuroptera (NE), Raphidioptera (RA), Homoptera and other food kind groups in the diet of bird nestlings collected by the neck–ring method in Slovakia during period of 1978–1993 (FM = foraging mode; FS = number of food sample; FI = number of food items)

Bird species	FM	FS	FI	Kind of food items (%)													
				NE	**RA**	**HO**	GL	IDC	AR	OR	HE	LE	CO	HY	DI	OT	PS
Parus ater	FG	206	1104	0.8	–	44.9	0.8	–	15.9	3.7	1.1	27.6	1.2	0.9	2.4	0.6	–
Parus caeruleus	FG	250	550	0.5	–	4.2	1.1	–	31.3	–	1.1	56.9	4.2	–	0.7	–	–
Parus major	FG	773	1287	0.1	–	2.3	1.8	–	18.9	1.1	–	60.3	5.4	0.2	9.5	0.2	0.4
Phylloscopus collybita	FG	233	1365	2.5	–	23.7	2.6	0.1	11.5	0.8	8.4	15.5	0.2	2.2	25.1	7.3	–
Phylloscopus sibilatrix	FG	90	312	3.9	0.6	10.6	4.5	–	17.6	–	4.1	11.2	5.8	1.6	38.8	1.3	–
Remiz pendulinus	FG	260	856	0.3	–	46.3	1.6	–	35.2	–	0.8	14.2	1.2	0.2	–	–	–
Certhia familiaris	BF	82	809	1.1	0.7	40.7	1.4	0.1	12.9	–	2.1	15.1	1.4	1.2	9.6	17.2	–
Dendrocopos major	BF	31	1390	0.1	0.5	14.9	0.1	0.4	4.7	–	0.7	6.3	8.2	47.8	11.5	0.1	5.0
Sitta europaea	BF	1585	10892	0.5	0.1	9.6	0.7	0.4	9.1	0.1	17.2	28.7	15.0	2.4	14.7	1.4	0.1
Erithacus rubecula	GF	150	457	1.5	–	11.8	0.7	6.6	17.5	0.2	0.7	16.6	14.0	8.8	16.6	4.8	0.2
Oenanthe oenanthe	GF	65	234	0.4	–	5.5	0.8	0.8	5.1	11.9	–	28.5	22.1	13.6	11.1	–	–
Prunella modularis	GF	173	3957	1.7	0.3	38.7	1.6	0.8	20.6	0.1	0.4	7.7	3.4	2.3	9.0	13.3	–
Troglodytes troglodytes	GF	94	522	–	0.2	15.1	–	6.9	29.1	–	1.0	7.1	1.5	–	29.9	9.2	–
Turdus merula	GF	86	160	1.2	–	0.6	18.8	10.7	4.9	–	0.6	34.4	12.4	4.4	8.8	0.1	3.1
*Merops apiaster**	AF	125	2174	0.1	–	–	–	–	–	0.2	2.6	2.9	16.3	70.5	5.1	2.3	–
Ficedula albicollis	GE	451	3432	1.6	4.4	4.3	0.3	2.7	12.3	0.4	5.6	16.3	19.3	14.4	18.0	0.4	–
Passer montanus	GE	1120	5820	0.1	–	25.8	0.8	–	4.4	0.2	1.3	29.0	20.8	0.7	12.4	0.1	4.4

Abbr.: FG= foliage gleaning, BF= bark foraging, GF= ground foraging, AF= aerial foraging, GE= generalist forager; NE= Neuroptera; RA= Raphidioptera; HO= Homoptera; GL= Gastropoda, Lumbricidae; IDC= Isopoda, Diplopoda, Chilopoda; AR= Araneae, Opiliones; OR= Orthoptera; HE= Heteroptera; LE= Lepidoptera; CO= Coleoptera; HY= Hymenoptera; DI= Diptera; OT= other insect groups; PS= plant seeds; * : food studied by pellet and stomach content analysis.

pod diet composition (%) of these 17 bird species is presented on Table 1. All birds preyed on Neuroptera except for one species, contrary to Raphidioptera, which could be found only in the food of 7 bird species. The proportion of Neuroptera and Raphidioptera ranged between 0.1–3.9% and 0.1–4.4%, respectively. The majority of bird species captured relatively few individuals from order Neuroptera, and lacewing dominance in their diet was below 1%. Neuropteran insects were represented with the highest (at least 1.5%) ratio in food of the 5 following bird species: *Phylloscopus sibilatrix* (3.9%), *Ph. collybita* (2.5%), *Prunella modularis* (1.7%), *Ficedula albicollis* (1.6%), and *Erithacus rubecula* (1.5%). These rates of Neuroptera are higher in bird food than their expected natural proportion within arthropod assemblages, which usually does not exceed 1% dominance value. Preference for lacewings found in food composition of House Martins (*Delichon urbica*) was explained by Bryant (1973) with their higher amount of fat. This factor might be responsible for the higher ratio in nestling diets of our study. We can observe that the ratio of homopteran insects is also generally higher (at least 10%) in cases of greater Neuroptera proportions (Table 1). It means that if birds hunt from plants strongly infected with aphid or psyllid colonies, than they also can encounter and prey on aphidophagous insects more frequently. Ratios of Raphidioptera stay under 1% except for one case (Table 1). They are mainly preyed upon by bark foragers. The exception *Ficedula albicollis*, which bird is a generalist forager, captured the individuals of Raphidiidae among arthropods in rate of 4.4%.

Species composition and dominance of neuropteroid insects in the food of birds

Table 2 shows the number of individuals of identifiable lacewing species collected by birds. Four species of Raphididiiae were recorded, overwhelming majority of them were imagines. *Dichrostigma flavipes* (D = 62%) and *Phaeostigma notata* (D = 31%) were represented with the highest dominance within the snake flies group (Table 3, column D). Birds captured individuals from seven species of the family of green lacewings. *Nineta pallida* was the most dominant (D = 70%), birds caught mainly its well-developed L_3 stage larvae. The proportion of *N. pallida* larvae was about three times greater than that of adults. In dominance rank of order *Dichochrysa prasina* was the second with nearly rate of 12%. Predominantly ground forager birds preyed on the latter lacewing species.

Five species were identified from the family of brown lacewings. Among them, *Hemerobius micans* proved to be the most dominant species (D = 69%). *Drepanepteryx phalaenoides* (14%) and *H. humulinus* (11%) followed it in the dominance rank order. While for chrysopids the larval stage was represented in the

Table 2. Number of individuals of identifiable neuropteroid species from food of birds collected in Central Slovakian forests over 1987–1993

Neuropteroid species	Bird species										
	Foliage gleaner					Bark forager			Ground forager		Gen.
	PMA	PAT	PCO	PSI	FCO	SEU	DMA	CFA	ERU	PMO	FAL
RAPHIDIIDAE											
Phaeostigma notata (FABRICIUS)				1		13					12
Dichrostigma flavipes (STEIN)				1	1	7	3	2			38
Xanthostigma xanthostigma (SCHUMMEL)								3			
Puncha ratzeburgi (BRAUER)						2					1
CHRYSOPIDAE											
Nineta pallida (SCHNEIDER)	1	6	17			4		1			1
Nineta flava (SCOPOLI)											2
Dichochrysa prasina (BURMEISTER)			1							4	
Chrysopa viridana SCHNEIDER			1								
Chrysopa abbreviata CURTIS											1
Peyerimhoffina gracilis (SCHNEIDER)									1		
Chrysoperla lucasina (LACROIX)						1					2
HEMEROBIIDAE											
Hemerobius micans OLIVIER			4	4		9			3	3	2
Hemerobius humulinus LINNAEUS						3					1
Hemerobius marginatus STEPHENS			1								
Sympherobius elegans (STEPHENS)			1								
Drepanepteryx phalaenoides (LINNAEUS)						5					

Abbreviation: Gen. = generalist forager; PMA = *Parus major*, PAT = *Parus ater*, PCO = *Phylloscopus collybita*, PSI = *Phylloscopus sibilatrix*, FCO = *Fringilla coelebs*, SEU = *Sitta europaea*, DMA = *Dendrocopos major*, CFA = *Certhia familiaris*, ERU = *Erithacus rubecula*, PMO = *Prunella modularis*, FAL = *Ficedula albicollis*

majority (73%) of food items against adults, in the case of hemerobiids the adults were dominant (64%), against larvae. Raphidiids was represented almost exclusively by imagines with a ratio of 98%.

Species composition of neuropteroids found in nestling food reflects well on forest vegetation of the given habitats, climatic conditions, preference for vertical distribution and abundance level of lacewings (see Table 3). There were mixed forests at the sampling sites, where both stands of deciduous tree species (*Quercus*, *Carpinus*, and *Fagus*) and coniferous trees (*Picea*, *Abies*, and *Pinus*) also occurred. These forests, especially their bushy borders, frequently have ecotones with drier and warmer microclimate. Comparing these characteristics of sites with the ecological requirements of recorded neuropteroid species, a noticeable coincidence can be found. Members of family Raphidiidae prefer xerothermous, lighter oak and coniferous forest stands living at shrub and foliage-crown level. Representatives of family Chrysopidae consist of mainly such abundant species that are ubiquitous. Two green lacewing species strongly indicate coniferous trees, namely *N. pallida* (prefers *Picea abies*) and *Peyerimhoffina gracilis* (prefers trees of *Picea* and *Abies* species). Other green lacewings are mainly inhabitants of deciduous forests. The brown lacewings found are ubiquitous and thermophilous species without exception, and they are usually abundant in deciduous forests and prefer vertically the foliage crown level. Those neuropteroid species, which are generally abundant in their habitats (*D. flavipes, N. pallida, Dichochrysa prasina,* or *H. micans*, Table 3), were also represented in greater proportion in the food of birds. The generalist feeder *F. albicollis* during its breeding period collects prey mainly by foliage-gleaning and bark-foraging hunter techniques. Snake flies often rest on tree barks, therefore they easily become preys of this bird. This explains the higher proportion of the two raphidiid species in the diet of *F. albicollis*.

Neuropteroid prey distributions among foraging modes and within foraging modes of birds

Table 4 and 5 summarises the two distribution types of neuropteroid foods. From the two distributions it can be see that foliage gleaners collected chrysopid prey at the highest rate (59.1 and 66.7%). This is understandable, since larvae of *N. pallida* living on pine foliage formed the majority of lacewing prey of birds. Hemerobiids were rather recorded in the diet of bark foragers (50 and 40%). The rate of brown lacewings in neuropteroid food of ground foragers was relatively high (61%), however it means only a few individuals (<10), mainly *H. micans*. A smaller proportion of hemerobiids (20 and 26%) appeared among prey of foliage gleaners, represented by the previous species as well. In both distribution types, the

Table 3. Characteristics of tree preference (TP), abundance level (ABL), xerothermo-preference (XTP), and vertical habitat preference (VHP) of the neuropteroid species and their percentage distribution in the food of bird nestlings captured by different foraging modes (FG: foliage gleaning, BF: bark foraging, GF: ground foraging, GE: generalist; D: species dominance% within neuropteroid family in food of birds) in Slovakia during 1987–1993

Neuropteroid species	TP	ABL	XTP	VHP	Foraging mode				D (%)
					FG	BF	GF	GE	
RAPHIDIIDAE									
Phaeostigma notata	Co,Q		XT	C	2.6	24.5		20.0	30.9
Dichrostigma flavipes	P,Q	A	XT	S,H	5.0	22.6		63.3	61.9
Xanthostigma xanthostigma	Co,Q		X	S		5.7			3.6
Puncha ratzeburgi	Co,Q		XT	C		3.8		1.7	3.6
Total					7.6	56.6		85.0	100
CHRYSOPIDAE									
Nineta pallida	P	A		C	61.5	9.4		1.7	69.8
Nineta flava	D	A	U	C,S				3.3	4.7
Dichochrysa prasina	D	A	U	C,S	2.6		36.4		11.6
Chrysopa viridana	Q		T	C,S	2.6				2.3
Chrysopa abbreviata				H				1.7	2.3
Peyerimhoffina gracilis	P,Ab			C			9.1		2.3
Chrysoperla lucasina		A	U	C,S,H		1.9		3.3	7.0
Total					66.7	11.3	45.5	10.0	100
HEMEROBIIDAE									
Hemerobius micans	Q,F,C	A	U	C	20.5	17.0	54.5	3.3	69.4
Hemerobius humulinus	D	A	U	C,S		5.7		1.7	11.1
Hemerobius marginatus	D		XT	S	2.6				2.8
Sympherobius elegans	Q,F		T	C	2.6				2.8
Drepanepteryx phalaenoides	Q,F	A	U	C		9.4			13.9
Total					25.7	32.1	54.5	5.0	100

Abbr.: Co: coniferous trees, D: deciduous trees, Ab: *Abies alba*, C: *Carpinus betulus*, F: *Fagus silvatica*, P: *Picea abies*, Q: *Quercus* spp.; A: abundant, U: ubiquist, T: thermophilous, X: xerophilous, XT: xero-thermophilous, C: tree-crown layer, S: shrub-layer, H: herbaceous-layer

Table 4. Distribution (%) of neuropteroid families as prey among different foraging groups of birds

Foraging mode	Neuropteroid family		
	Chrysopidae	Hemerobiidae	Raphidiidae
Foliage gleaners	59.1	20	3.6
Bark foragers	15.9	50	35.7
Ground foragers	11.4	16	0
Generalists	13.6	14	60.7
Total	100	100	100

family Raphidiidae was represented in considerable proportions (61 and 80%) in the food of generalist birds. However, as we earlier referred to the change in hunting mode of *F. albicollis* during its breeding season, this high rate of snake flies among the neuropteroid foods is probably a consequence of its prey collecting activity on bark surfaces. The remaining proportion of snake flies (36 and 48%) was found in food of bark foragers.

Seasonal distribution of neuropteroid insects in food of nestlings

The seasonal distribution patterns of the three neuropteroid families in diets of nestlings are similar to each other (Fig. 1). Birds collected most larvae and imagines in the main breeding period, from mid-May to the first decade of June. A smaller proportion of lacewings were still among prey-items in the second half July, snake flies even in the late June – early July period. Among chrysopids the high frequency of larvae of *N. pallida* in food items is reasonable, since this species overwinters in its larval stage. At the same time the hemerobiid, *D. phalaenoides* was also found by birds in early season because it overwinters as an imago. There is no significant difference between the seasonal distributions of neuropteroid families (Fig. 1), which indicates that they were depended mainly on food collecting frequency of birds, contrary to Hungarian study (SZENTKIRÁLYI & TÖRÖK 1983),

Table 5. Proportion (%) of abundance of the neuropteroid families in the nestling foods of bird groups with the same foraging mode

Neuropteroid family	Foraging mode			
	Foliage gleaners	Bark foragers	Ground foragers	Generalists
Chrysopidae	66.7	11.3	38.5	9.4
Hemerobiidae	25.6	40.3	61.5	10.9
Raphidiidae	7.7	48.4	0	79.7
Total	100	100	100	100

where the 3 families appeared in bird foods with a distribution reflecting their natural seasonality.

CONCLUSIONS

(1) In prey composition of nestlings, 4 raphidiid, 7 chrysopid, and 5 hemerobiid species were recorded. The most abundant neuropteroid species in diets were *Dichrostigma flavipes*, *Nineta pallida* and *Hemerobius micans*.

(2) The proportion of different neuropteroid groups varied according to the foraging mode of the birds. Within neuropteroid food composition of foliage gleaners, the chrysopids were represented by the greatest dominance (68%), while hemerobiids had lower proportion (26%). The bark foragers collected the snakeflies and brown lacewings almost in equal portions, 48% and 40%, respectively. In the diet composition of ground foragers only a few number of neuropteroids were present (chrysopids 43% and hemerobiids 57%). The generalist feeding birds captured predominantly raphidiids (79%).

(3) Investigated birds caught the most individuals from the three neuropteroid families in the period between second ten days of May and first ten days of June. The seasonal distribution pattern of neuropteroids in foods depended on collecting frequency of birds.

*

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CONTRIBUTION TO KNOWLEDGE OF FEMALE INTERNAL GENITALIA OF NEUROPTERA

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In continuing earlier research on female internal genitalia (FEIG) of Neuroptera, further examinations were carried out on some species of the families Coniopterygidae and Ascalaphidae. In the coniopterygid subgenus *Metaconiopteryx* KIS, 1968 the correct association of females with the corresponding males became possible as a result of the examination of FEIG of the type material of *Coniopteryx (Metaconiopteryx) arcuata* KIS, 1965. A comparison of male and female internal genitalia in this subgenus suggests that a lock and key mechanism was involves in the evolution of this group. As regards the family Ascalaphidae, four taxa, *Ascalaphus sinister* WALKER, 1853, *Bubopsis andromache firyuzae* SZIRÁKI, 2000 (Ascalaphinae), *Idricerus sogdianus* MCLACHLAN, 1875 and *Protidricerus elwesi* (MCLACHLAN, 1875) (Haplogleniinae) were investigated. In FEIG of these species no distinctive features were found for separation of the two ascalaphid subfamilies.

Key words: Ascalaphidae, Coniopterygidae, female internal genitalia, lock and key mechanism, male genitalia, *Metaconiopteryx*

INTRODUCTION

In course of the initial investigation of female internal genitalia (FEIG) of coniopterygid species occurring in Hungary (SZIRÁKI 1992*c*) the four *Coniopteryx (Metaconiopteryx)* KIS, 1968 species, among others, were studied and described. Recently I had the opportunity to examine the type material of *Coniopteryx (M.) arcuata*, and an alteration subsequently became necessary in two of the four species.

Female internal genitalia have been poorly investigated in ascalaphids as well as in most other groups of Neuroptera, although detailed studies of this organ system would be useful for more accurate determination of these insects. The aim of present research was to investigate the question, if there are any differences in the structure of FEIG of the two traditionally recognized subfamilies (Ascalaphinae and Haplogleniinae) of the family Ascalaphidae.

MATERIALS AND METHODS

All the investigated material is deposited in the collection of the Hungarian Natural History Museum. The method used for studying the ectodermal parts of FEIG was the same as it was detailed in earlier papers (*e.g.* SZIRÁKI 1992*a*). As regards the male genitalia, I follow the terminology used by MEINANDER (1972), while terminology of female internal genitalia is as in SZIRÁKI (1998, 2000).

RESULTS

CONIOPTERYGIDAE

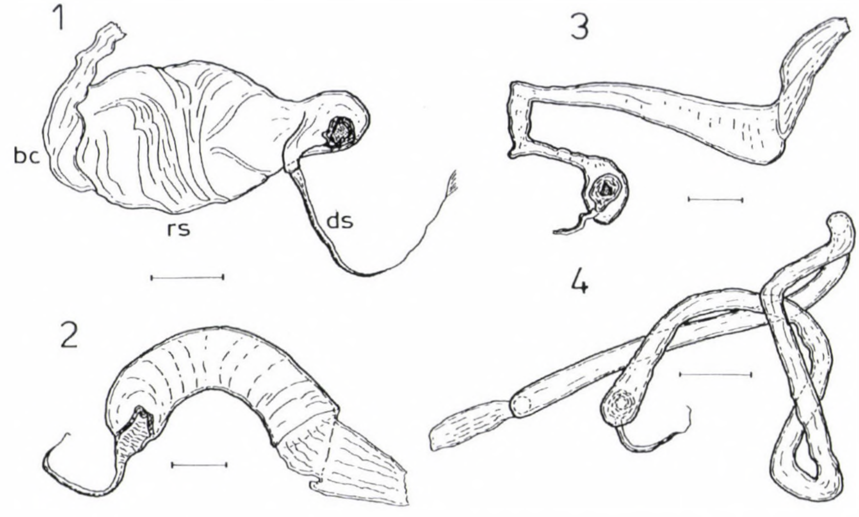
In our earlier work on the FEIG of the four *Metaconiopteryx* species, investigation of *Coniopteryx (Metaconiopteryx) esbenpeterseni* TJEDER, 1930 was the first step. In this case association of females with the corresponding males was done on the basis of a pair of insects having been collected in copula (SZIRÁKI 1992*a*: Figs 29–32, 1992*c*: Fig. 14), and for this reason it seemed to have a high probability.

After this, the females which had the most similar, but differing internal genitalia compared with "*C. (M.) esbenpeterseni*", were regarded as representatives of *C. (M.) arcuata* (SZIRÁKI 1992*a*: Figs 26–28, 1992*c*: Fig. 17.), as the male internal genitalia of the above mentioned two species are the most similar to each others within the subgenus *Metaconiopteryx* (Figs 5–6).

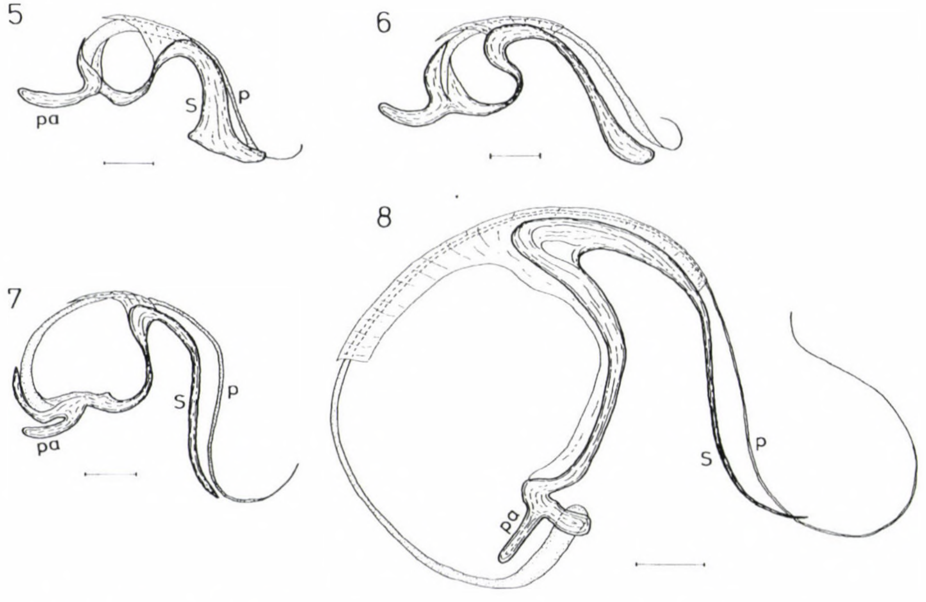
On the other hand, it is worthmentioning that these females were usually collected with either males of *C. (M.) esbenpeterseni* or with males of *C. (M.) arcuata* KIS, 1965), or together with both of them.

After the examination of the type material of *C. (M.) arcuata* it turned out that the FEIG regarded earlier as this organ of *C. (M.) esbenpeterseni* (SZIRÁKI 1992*c*: Fig. 14) really belong to *C. (M.) arcuata* (Fig. 1). Hence it follows that (1) FEIG thought earlier to be this organ of *C. (M.) arcuata* (SZIRÁKI 1992*c*: Fig. 16) actually belongs to its nearest related species, *C. (M.) esbenpeterseni* (Fig. 2), and (2) the earlier association of a female *C. (M.) arcuata* with a male of *C. (M.) esbenpeterseni* was the result of an interspecific copulation.

As regards the two other *Metaconiopteryx* species, populations of *Coniopteryx (M.) lentiae* H. ASPÖCK et U. ASPÖCK, 1964 or *Coniopteryx (M.) tjederi* KIMMINS, 1934 are distinguishable from populations of *C. (M.) arcuata* owing to some eidonomical features (SZIRÁKI 1992*b*), while *C. (M.) tjederi* is close to *C. (M.) lentiae*, but their coexistence is rare. The association of females with the corresponding males, and description of their FEIG was consequently correct in the case of the latter two species in 1992.



Figs 1–4. Bursa copulatrix and receptaculum seminis of *Coniopteryx (Metaconiopteryx)* species: 1 = *Coniopteryx (M.) arcuata*, 2 = *C. (M.) esbenpeterseni*, 3 = *C. (M.) lentiae*, 4 = *C. (M.) tjederi*, bc = bursa copulatrix, ds = ductus seminalis, rs = receptaculum seminis. Scale in Figs 1–3: 0.03 mm, in Fig. 4: 0.06 mm



Figs 5–8. Male genitalia of *Coniopteryx (Metaconiopteryx)* species: 5 = *C. (M.) arcuata*, 6 = *C. (M.) esbenpeterseni*, 7 = *C. (M.) lentiae*, 8 = *C. (M.) tjederi*, p = penis, pa = paramere, s = stylus. Scale in Figs 5–7: 0.03 mm, in Fig. 8: 0.06 mm. (after ASPÖCK *et al.* 1980)

As a result of the correction discussed above, a distinct correspondence in the structure of male and female internal genitalia of the same *Metaconiopteryx* species appeared. The relatively short and broad male internal genitalia of *C. (M.) arcuata* belong to a relatively short and wide bursa copulatrix + receptaculum seminis, and the narrower and longer the male internal genitalia, FEIG also the narrower and longer in the three other species (Figs 1–8). This pattern of the structure of internal genitalia of both sexes suggests that a lock and key mechanism was involved in the evolution of this coniopterygid group.

ASCALAPHIDAE
Ascalaphinae

Ascalaphus sinister WALKER, 1853
(Figs 9–10)

Material examined: Laos, Prov. Champarsak, Dong Hua Xao, 2 km S of Nong Luong, 1–5. 04. 1998, leg. G. CSORBA and O. MERKL – 1 female specimen.

Vagina short and wide. Bursa copulatrix and receptaculum seminis are only slightly separated. In dorsal view the bursa copulatrix somewhat elongated, with a widened caudal part. Its wall is wrinkled and moderately sclerotized.

The free part of ductus seminalis is rather wide, relatively short, entirely covered by glandular setae and originates from the posterior part of the receptaculum seminis, where its wall is strongly sclerotized because of a sphincter. It is probable, that the "original basal part" of ductus seminalis, which may be found in some other ascalaphids, in this case melt into the spermatheca entirely. The ectodermal part of the oviduct is distinctly sclerotized with internal setae.

The postbursal accessory gland has a round reservoir with a short and wide duct, and with a pair of extremely long, distally narrowing tubes.

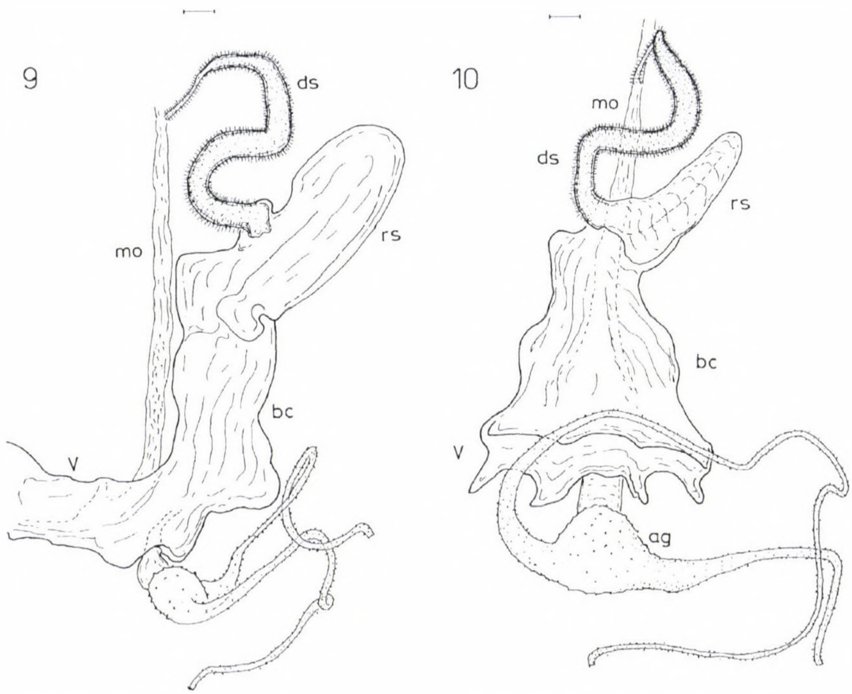
Bubopsis andromache firyuzae SZIRÁKI, 2000
(Fig. 11)

Material examined: Turkmenia, Kopet Dagh Mts, Firyuza, 400 - 600 m. a.s.l., 25.06.1992, leg. GY. FÁBIÁN, B. HERCZIG, A. PODLUSSÁNY, Z. VARGA – 1 female specimen (paratype).

Vagina relatively long, flat, but rather wide. The bursa copulatrix narrow in lateral view, with strongly sclerotized walls. Receptaculum seminis large and pyriform.

Ductus seminalis broader after the median loop than before, sharply turning before the end, moderately wide and long. Its free, looped part covered by glandular setae, while its basal part originates from a knob of the receptaculum seminis, runs backwards, and connected to the ventral surface of spermatheca, and partly of bursa copulatrix. Ectodermal part of the oviduct distinctly sclerotized.

Postbursal accessory gland has a reservoir with a short and wide duct and a pair of long tubes.



Figs 9–10. Female internal genitalia of *Ascalaphus sinister*: 9 = lateral view, 10 = dorsal view, ag = postbursal accessory gland, bc = bursa copulatrix, ds = ductus seminalis, mo = median oviduct, rs = receptaculum seminis, v = vagina

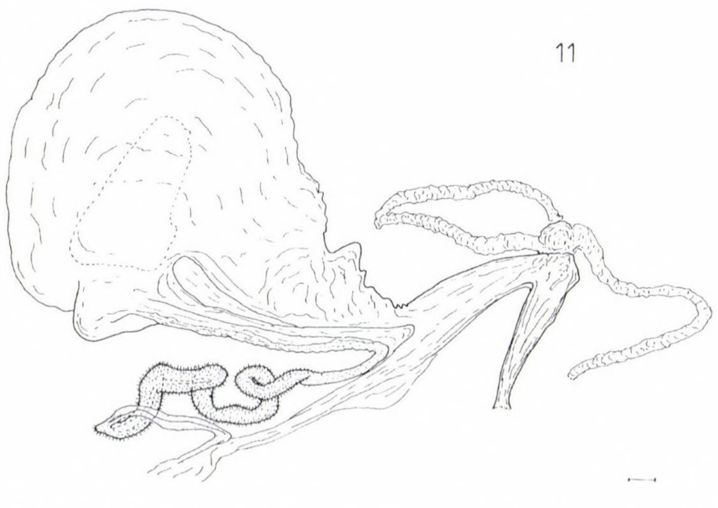


Fig. 11. Female internal genitalia of *Bubopsis andromache firyuzae*, lateral view. Scale: 0.08 mm. (after SZIRÁKI 2000)

Haplogleniinae

Protidricerus elwesi (MCLACHLAN, 1891)
(Figs 12–13)

Material examined: Pakistan, Islamabad, 26–27. 06. 1992, leg. G. CSORBA and M. HREBLAY – 1 female specimen.

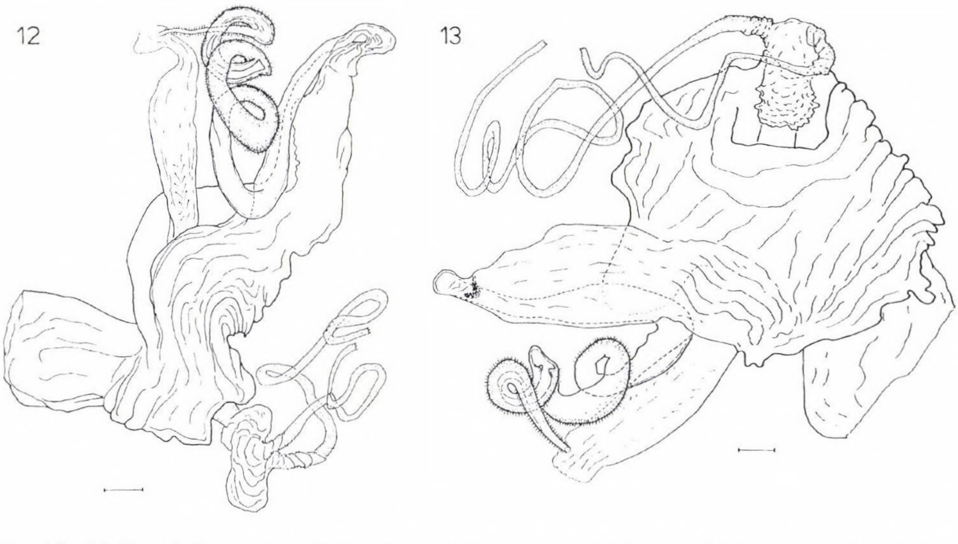
Vagina very broad. Bursa copulatrix strongly sclerotized and wrinkled, about as long as wide in dorsal view. Receptaculum seminis elongated, with thin walls.

Ductus seminalis rather long, and only partly covered by glandular setae only. Its basal part begins at a knob on the tip of the receptaculum seminis with a sphincter and runs backwards. The split sclerotization (SZIRÁKI 1998) of the terminal loop of this organ is very strong. The ectodermal part of the oviduct distinctly sclerotized, with moderately long internal setae.

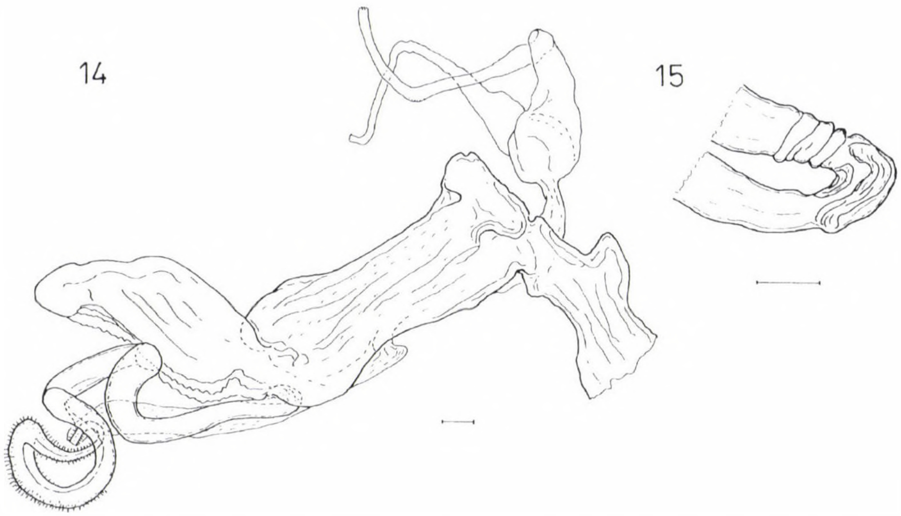
The reservoir of the postbursal accessory gland elongated with a wrinkled dorsal surface. Basal part of the two tubes very wide with some irregular annulations.

Idricerus sogdianus MCLACHLAN, 1875
(Figs 14–15)

Material examined: Kazachstan, valley of Issy, 21. 08. 1997, leg. A. Orosz – 1 female specimen; Kazachstan, Alma-Ata, 21. 07. 1958, leg. N. Scopin – 1 female specimen; Jammu and Kashmir under administration of Pakistan, Sost, 16. 06. 1992, leg. G. CSORBA and M. HREBLAY – 2 female specimens.



Figs 12–13. Female internal genitalia of *Protidricerus elwesi*: 12 = lateral view, 13 = dorsal view. Scale: 0.08 mm



Figs 14–15. Female internal genitalia of *Idricerus sogdianus*: 14 = the whole internal genitalia in lateral view, 15 = bend of ductus seminalis with sphincter, ventral view. Scale in Fig. 0.08 mm, in Fig 15: 0.04 mm

Vagina moderately broad and strongly sclerotized. Bursa copulatrix somewhat elongated. Its wall moderately sclerotized only, with internal setae. Receptaculum seminis weakly sclerotized and moderately large.

The basal part of ductus seminalis with very thin walls, attached to the spermatheca and runs backwards. Later this duct turns forwards. In this bend there is a sphincter, and from this point the sclerotization is strong. Glandular setae are situated on the terminal loop. Ectodermal part of the oviduct weakly sclerotized with internal setae.

Reservoir of the postbursal accessory gland globular, while its duct somewhat elongated and curved. The basal part of the two tubes is very broad and tapering gradually.

CONCLUSIONS

In the case of the coniopterygid subgenus *Metaconiopteryx* KIS, 1968 the correct association of females with the corresponding males was possible as a result of the examination of female internal genitalia of the type material of *Coniopteryx (Metaconiopteryx) arcuata* KIS, 1965. Moreover, a comparison of the male and female internal genitalia in this subgenus suggests that a lock and key mechanism was involved in the evolution of this group of Neuroptera.

According to the results of morphological studies on Ascalaphidae, FEIG of the examined species are rather similar to each others. However, two basic types may be recognized.

In the first case (Type I) the well sclerotized basal part of the ductus seminalis originated from a knob on the anterior part of receptaculum seminis, with or without distinctly sclerotized parts of a sphincter (surely with a pumping function). From here the duct runs backwards, and more or less is connected to receptaculum seminis. Near to the connection of spermatheca and bursa copulatrix it turns forwards and after some loops reaches the median oviduct (Figs 11–13).

In the second case (Type II) the basal section of ductus seminalis merged into the receptaculum seminis, or at least is connected tightly to this organ, and thin walls are present in this position. Near to the connection of the spermatheca and bursa copulatrix it becomes free, contains a sphincter, turns forwards with strongly chitinized walls, and after a few loops reaches the median oviduct (Figs 9–10, 14–15 and SZIRÁKI 1996: Fig. 26).

The main difference between the two types is that in FEIG "Type II" the structure supporting a pumping function situated in the bend of the ductus seminalis near to the connection of bursa copulatrix and spermatheca, while in "Type I" it is proximal to this part.

From a phylogenetical point of view, the FEIG "Type I" seems to be the plesiomorphic character state, as this is very similar to female internal genitalia of *Palpares libelluloides* (LINNAEUS, 1764) (SZIRÁKI 1996: Fig. 25) and of *Acanthaclisis occitanica* (VILLERS, 1789) (unpublished). The latter species is an ancient representative of the family Myrmeleontidae (KRIVOKHATSKY 1998), the nearest relative of Ascalaphidae.

On the other hand, the examined species with one of these two types of FEIG are not the same as those which belong to one or to other subfamily of Ascalaphidae. *Bubopsis andromache firyuzae* (Ascalaphinae) and *Protidricerus elwesi* (Haplogleniinae) have FEIG "Type I", while *Ascalaphus sinister* (Ascalaphinae), *Idricerus sogdianus* (Haplogleniinae) and *Libelloides sibiricus* (Ascalaphinae) (SZIRÁKI 1996) have "Type II". Consequently, FEIG of the hitherto investigated species do not offer further distinctive features for the separation of the subfamilies Ascalaphinae and Haplogleniinae, and the apomorphic character state in FEIG "Type II" developed independently in the two subfamilies – supposing that they really are monophyletic groups.

*

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SELECTIVE ATTRACTIVITY OF ARTIFICIAL OVERWINTERING CHAMBERS FOR THE COMMON GREEN LACEWING SPECIES OF THE CHRYSOPERLA CARNEA (STEPHENS) COMPLEX IN WESTERN EUROPE (NEUROPTERA: CHRYSOPIDAE)

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The aim of this work is to test attractivity of different types of substrats in overwintering chambers for the common green lacewing species. Experiments were carried out in France near of Angers (48°28'N, 00°33'E) during winter 1999–2000. Sheets and rolls of corrugated cardboard, and staw were used as substrats.

Chambers were colonized by a large numbers of *Chrysoperla kolthoffi* (NAVÁS). The number of lacewings was two times greater in straw than in corrugated cardboard. The suitability of staw was confirmed.

Only 5 *Chrysoperla carnea* s. s. (STEPHENS) were collected, This species seemed to overwinter in more ventilated cavities than our confined boxes. Only one *Chrysoperla. lucasina* (LACROIX) was found.

Our device can already be used to improve the number of overwintering *Ch. kolthoffi* near the crops. In order to develop overwintering chambers as a proper tool for studing overwintering guild structures further experiments are needed with *Ch.carnea*, *Ch. lucasina* or other species.

Key words: lacewing, *Chrysoperla kolthoffi*, biological control, overwintering chamber

INTRODUCTION

The common green lacewing *Chrysoperla carnea* (STEPHENS) sensu lato is generally considered a major component of beneficial entomofauna in agroecosystems. Larva instars are oophagous or/and aphidophagous and can feed on numerous other arthropods.

As generalist predators they are mass reared and sold for releases in glasshouse or in field crops (PAULIAN 1999, MAISONNEUVE & MARREC 1999, RAT-MORRIS 1999).

IPM programmes develop strategies to improve the settlement of released species and to protect spontaneous beneficial populations. Flying movement of adult lacewings which could be compulsory and sometimes on a wide area may be an impediment for using those insects in IPM programmes.

In natural conditions, the developmental pattern of those insects is a facultative multivoltinism (CANARD 1998, CANARD & VOLKOVICH 2001). There is at

least two generations a year in western Europe (ŽELENY 1965). Short late-summer days induce ovarian diapause of adults which is completed at mid-winter whithout any particular stimulus. In autumn, after an intensive feeding period allowing the constitution of lipidic reserves (LEMESLE *et al.* 1998), diapausing adults start seeking for suitable overwintering sites (GEPP 1967)

Adults show a thermic quiescence resulting of low temperature during winter, the insects resume reproductive activity only in spring and simultaneously leave their wintering shelters. A few days later, females begin to lay eggs and offspring predaceous larvae will colonize all the outwood strata of vegetation.

To avoid excessive mortality and to further establish lacewings near the field, SENGONCA and FRINGS (1989) developed in Germany hibernating chambers packed with straw. The authors showed the efficiency of such a device to be colonized by a large number of lacewings and gave some advice: – (i) wooden (plywood) chambers are preferred to plastic ones – (ii) the orientation and the opening of the chamber must minimize inside air movements – (iii) green or red external color inducing fast warming up is more suitable than darker colours. MCEWEN (1998) showed that. (i) internal surface of the box is a key factor for the number of lacewing colonizing it (ii) and that caryophylene as possible attractant had no effect (MCEWEN *et al.* 1999). No work carried out in the field has given data concerning *Chrysoperla lucasina* (LACROIX) and *Chrysoperla kolthoffi* (NAVÁS) which are the two widely distributed species in western Europe (THIERRY *et al.* 1996). Morever both of these two species are reared and distributed by factories for releasing in IPM and organic farming (MAISONNEUVE, pers. com.). Nevertheless in nature the study of temporal changes in overwintering sites revealed marked differences between the species habits (THIERRY *et al.* 1994). In underwood biotopes, *Ch. carnea* s. s. has been found in dry leaves staying in the vegetation from about 20 cm to 3 m up or coexisting with *Ch. lucasina* in ivy tufts invading bushes, whereas *Ch. kolthoffi* is overwintering in unheated and dark parts of buildings.

The aim of this work is to test attractivity of different types of substrats in wintering chambers for the common green lacewing species.

MATERIALS AND METHODS

Construction of lacewing chambers took inspiration from the design outlined by SENGONCA and FRINGS (1987) (Fig. 1). It consists of a wooden box (50 cm × 30 cm × 30 cm (1)); untreated pine wood was used to avoid alteration of insect behaviour due to chemical protection. The box was closed by a fiber-board front side (2) which was drilled randomly by thirty five 15 mm diameter holes. This front side was designed to be easily removed to check the content of the chamber. Each chamber was divided vertically in three compartments (Fig. 2) the lower part leaving free as a crawl space (a). Partitioning was done with 20 mm wire netting (b)

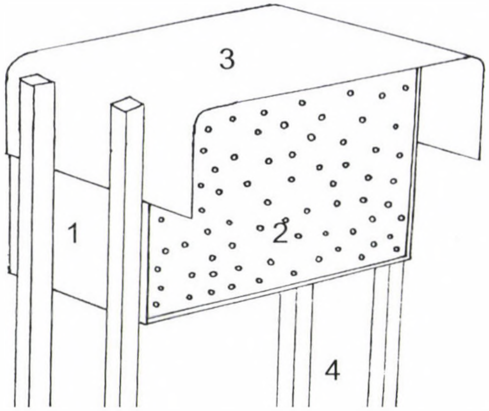


Fig. 1. General view of the overwintering chamber. (1) wooden box, (2) fiber-board front side, (3) plastic plate roof and (4) wooden pool

to allows easy insect movement from one compartment to an other. A green plastic plate was stapled as a roof (3) on top and lateral sides of the box with an eave to protect the front side from rain and wind. Each chamber was bolted to four wooden poles (4) 170 cm above ground level facing away from the dominant wind direction (western wind in our conditions) as proposed by McEWEN (1998). Corrugated cardboard was used as a substrate for the lateral compartments : in one compartment sheets were piled up (c), a compact roll was inserted vertically in another compartment, while the middle compartment was tightly filled with straw.

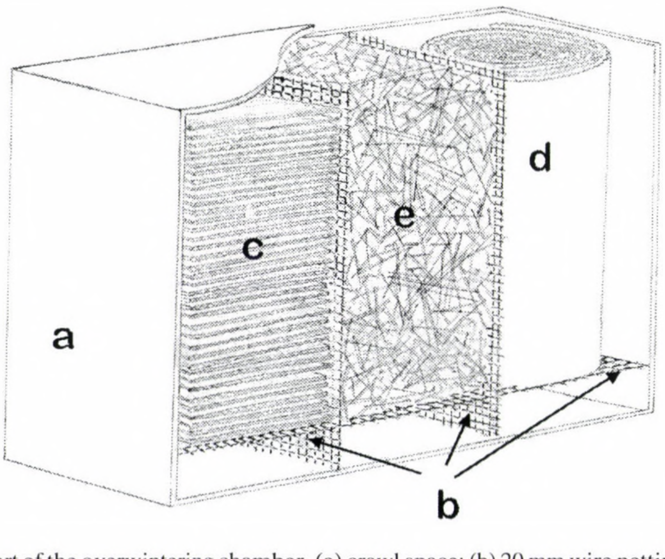


Fig. 2. Inside part of the overwintering chamber. (a) crawl space; (b) 20 mm wire netting; (c) sheets of corrugated cardboard, (d) roll of corrugated cardboard and (e) straw

Experiments were carried out in France in four stations whithin a 50–kilometer area in the Loire valley around Angers (48°28'N, 00°33'E) (Fig. 3). Two stations were located in sub-urban areas (1 and 2) and two others far away from the town in a farming zone: one in the south (3) and the last in the north (4). During the first week of November 1999 four chambers were placed in each station. As far as the station environment made it possible, the chambers were placed in four situations : (i) in a protected or field seed crop area, (ii) near a hedgerow, (iii) underwood, (iiii) near a expected overwintering site of *Ch. kolthoffi* (farmsheld and/or woodshed).

The boxes were removed during the first week of February. They were placed individually in plastic bags and quickely transferred in a cold room (4±1°C) to keep insects in thermic quiescence and inhibit their moving inside the chambers. The chambers were then checked in the laboratory and the lacewing location recorded as precisely as possible. The lacewings were then identified.

RESULTS AND DISCUSSIONS

Except one individual, no lacewing have been found in boxes in sub-urban areas; conversely 18 and 99 lacewings were found respectively in stations 3 and 4. Different hypothesis could be proposed to explain those results: – (i) guild density is lower in sub-urban areas which are more drastically perturbated by human activity than in farming areas and particularly in station 4 where IPM programmes have

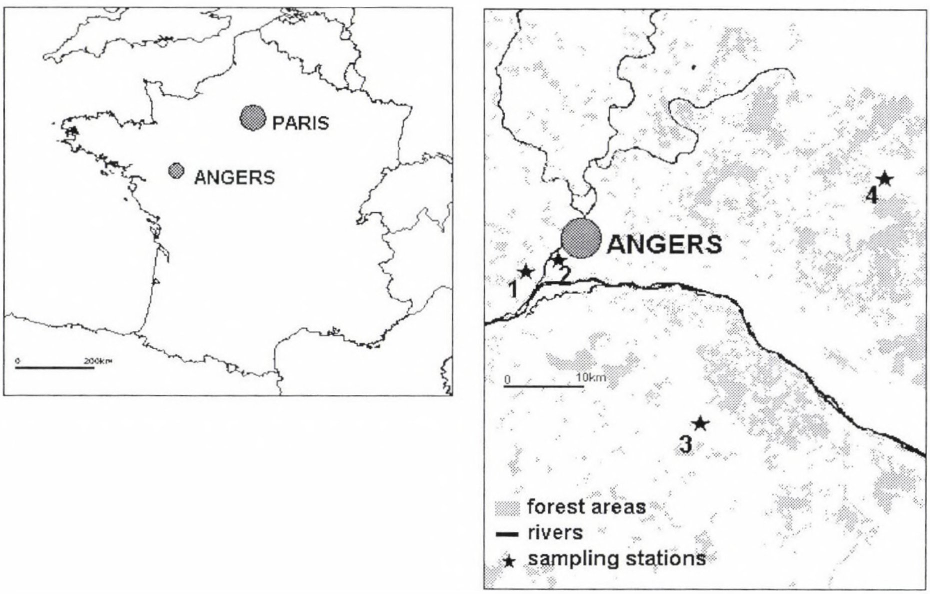


Fig. 3. Situation of the four experimental stations

Table 1. Number of individuals of *Chrysoperla kolthoffi* collected in the chambers located in stations 3 and 4

Location in the station	cultivated field	hedgerow	underwood	farmshed / woodshed
Station 3	8	2	0	8
Station 4	19	30	17	27
Total	27	32	17	35

been perfomed for three years (GALEZ *et al.* 1998) – (ii) numerous unheated parts of building offer alternative overwintering sites more suitable than our chambers – (iii) the outline of buildings could disturb the lacewing in their orientation towards the chambers (MCEWEN 1998).

Chrysoperla kolthoffi was the main species collected (111 individuals). Even if the chamber construction and the substrates were more suitable for *Ch. kolthoffi* than for others species, we note the similarity between these results and our present knowledge of the distribution of this species, which is always dominant in the atlantic part of Europe (THIERRY *et al.* 1996). As reported by THIERRY (1991) concerning overwintering sites (unheated parts of building), females are slightly more numerous (55%).

The number of *Ch. kolthoffi* was quite equal in stacked sheet and rolled corrugated cardboard, but two times greater in straw. The suitability of this last substrate is confirmed. May be, as dry foliage used by SENGONCA and FRINGS (1989), cardboard did not provide enough space for adult *Ch. kolthoffi* to hide.

Most of the lacewings were found hidden inside straw or between the cardboard lying and not in the periphery. This observation is not consistent with SENGONCA and FRINGS (1989) who recorded 94% of lacewings aggregated in area at least 4 cm distant of the louvered front of chambers.

A total of 5 *Chrysoperla carnea* s. s. were collected, 4 were found ouside the boxes, between the green plastic plate and the upper side, only one was found in straw. *Ch. carnea* s. s. seemed to overwinter more in ventilated cavities than the confined, and always rather humid, atmosphere of our boxes. This preferendum could be related with our knowledge of the overwintering sites of this species in the field.

Table 2. Location of *Chrysoperla kolthoffi* within the chambers

Location within the chamber	straw	sheets of cardboard	rolled cardboard	periphery of substratum
Station 3	9	8		1
Station 4	47	22	19	5
Total	56	30	19	6

Only one *Ch. lucasina* was found in the chamber located in station 4 in straw substrate. This species is rare in Loire Valley although in station 4, it was been mass introduced during three years of IPM programmes. Obviously, this species is not attracted by our device. As for *Ch carnea* s. s., the chamber construction that we tested seemed to be unsuitable.

Our device can already be used to improve the number of overwintering *Ch. kolthoffi* near the crops. In order to develop overwintering chambers as a proper tool for studing overwintering guild structures further experiments are needed with *Ch.carnea, Ch. lucasina* or other species.

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PRELIMINARY SURVEY OF THE LACEWINGS (NEUROPTERA: CHRYSOPIDAE, HEMEROBIIDAE) IN AGROECOSYTEMS IN NORTHERN FRANCE, WITH PHENOLOGICAL NOTES

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A survey of lacewings was undertaken in an agricultural zone of northern France. Adults were investigated in four cultures: strawberry, potato, witloof and kidney bean, and in apple orchards. A fixed suction trap gave an overview of the lacewing assemblage present. Yellow trap together with portable suction-device collections showed the hemerobiids and chrysopids currently harboured. Stalked eggs, larvae and cocoons of chrysopids were sampled in strawberry, potato, cabbage and carrot, and in apple-tree orchards. Rearing in the laboratory of all preimaginal instars of the green lacewings collected bore witness to the actual establishment of any species in the field.

Seven green lacewings species were identified, but the lacewing diversity is low. In all cases, the eurytopic generalist predator *Chrysoperla kolthoffi* was the dominant species. Adults flied from May (wintering generation) to autumn, showing a peak in July. The occurrence of preimaginal instars suggests three generations. Four brown lacewing species were recorded, among them *Micromus variegatus* was the most abundant. They flew mainly in July and August.

Key words: chrysopid, *Chrysoperla kolthoffi*, hemerobiid, pest predator, biological control, agroecosystem

INTRODUCTION

Need of food of high quality for the west European market is increasing significantly so that Integrated Pest Management (IPM) or organic farming now becomes a concern for agronomists in charge of farmers' advice. Crops must be harvested free of chemicals and their protection against phytophagous pests must be managed more and more by alternative methods. In this way, naturally occurring generalist predators may play a key role. Among them, the green and brown lacewings show many favourable traits such as widespread prey range and high voracity (see review in MCEWEN *et al.* 2001).

The aim of the present report is to feature which lacewings occur in agricultural zones grown over with various low crops and orchards, which species are really established and when they are active.

MATERIALS AND METHODS

This study was carried out in northern France, "Région Nord, Pas-de-Calais", in the southern part of the Flanders plain. It is an agricultural zone of strong tradition of vegetable and fruit production. The target fields are of commercial type. They are all managed with soft cultural techniques: either in supervised management (lutte raisonnée), in integrated pest management (lutte intégrée) or in strict organic farming (agriculture biologique). Several crops and their nearby uncultivated biotopes were sampled (Table 2). Strawberry, potato, witloof, tobacco and kidney-bean were chosen for analysis of adult occurrence of both green and brown lacewings. They are regularly sampled during the growing season 1999, from May to October. The neighbourings of the experimental areas are constituted of other similar crops in which chemicals were used according to the usual advise programmes.

Adult lacewings were collected by several methods (Table 1). Besides, a fixed Taylor suction device operated approximately in the centre of the experimental zone. It gave an overview of the aerial neuropteran guild occurring in the district. It collected permanently at 12.2 m high. To estimate the actual neuropteran fauna possibly associated with plant stands, restricted samples were taken in each crop. Two standard yellow traps were set out in each plot, at 0.9 m high and 10 m intervals; specimens captured were taken out twice a week. A mobile individual vacuum device was used by day, during a time unit ranging from 30 secondes to five minutes. In addition, specimens were swept by hand net; other individuals were offered a feeding McPhail trap baited with 5% diammonium phosphate or they entered casually an INRA noctuid control pheromone trap working in the experimental area. All collected adults were stored in vials containing alcohol 70% + glycerol 5% and kept in the "Station d'Études sur les Luttes Biologique, Intégrée et Raisonnée, Service Régional de la Protection des Végétaux (FREDEC)", Loos-en-Gohelle, France.

As hemerobiid eggs are difficult to see on plants, only the stalked eggs of chrysopids were investigated in four low cultures: strawberry, potato, cabbage and carrot, and in apple orchards. The preimaginal instars of only green lacewings were also collected. Some eggs were regularly picked up, and some larvae and cocoons were collected. All were brought to the insectarium for further development allowing identification of adults.

Rearing cabinets were conditioned as following: the temperature was 20±1°C, relative humidity was 70±10%, the photoperiod used provided 16 hours of light per day to inhibit the possible induction of diapause. The larvae were kept in individual vials to avoid cannibalism. They were fed with sterilized eggs of *Ephestia kuehniella* (ZELLER) given every day *ad libitum*.

To state the brood phenology, the larvae collected are registered in Figure 3 with an earlier time displacement proportional to their estimated embryogenesis and larval development duration.

Four indices were calculated to quantify the biodiversity. Taxonomic species abundance [S], i.e. the number of species collected, provides a rough evaluation of habitat richness. The diversity is also characterized by the most widely used index, the Shannon's diversity index [H'] proposed by SHANNON and WEAVER (1963):

$$-\sum_i \left(\frac{q_i}{Q}\right) Log_2 \left(\frac{q_i}{Q}\right)$$

where qi = the number of individuals in theith taxa and Q = the total number of individuals.

We calculated two more indices measuring dominance which are independent on sample size:
– the McIntosh's diversity index [D(MI)] (McINTOSH 1967):

$$\frac{Q - d(MI)}{Q - \sqrt{Q}}$$

where $d(MI) = \sqrt{\sum_i (q_i)^2}$ is the McIntosh's distance or Eucledian distance.

The McIntosh's index is sensitive for the dominant taxa (BEISEL *et al.* 1996) and by the way not subject to aggregative distribution;

– the Simpson's dominance index [λ] (SIMPSON 1949), modified by BERGER and PARKER (1970):

$$\frac{\sum_i q_i (q_i - 1)}{Q(Q-1)}$$

The Simpson's index is slightly more sensitive for samples showing low dominance and more efficient to characterize rare taxa distribution than the previous McIntosh index.

RESULTS AND DISCUSSION

The wandering lacewing species

Cumulating all collecting methods, six species of green lacewings were recorded as adults in the agricultural experiment area. They were in decreasing order of relative abundance: *Chrysoperla kolthoffi* (NAVÁS, 1927), *Chrysopa phyllochroma* WESMAEL, 1841, *Chrysoperla carnea* (STEPHENS, 1836), *Chrysopa perla* (LINNAEUS, 1758), *Dichochrysa flavifrons* (BRAUER, 1850), *Cunctochrysa albolineata* (KILLINGTON, 1935) (Fig. 1).

All these chysopids are common constituents of the European fauna. *Chrysopa phyllochroma* and *C. albolineata* also occur in Asia up to Korea and Mongolia, and *D. flavifrons* has a holomediterranean distribution range including Mediterranean islands and the Maghreb.

The number of specimens appear in Table 1 as a function of sampling techniques and in Table 2 as a function of crops sampled. One can note that the McPhail trap did not attract any lacewing, neither chrysopid nor hemerobiid, contrarily to other conditions in which it constitutes a satisfying method (*e.g.* NEUENSCHWAN-

Table 1. Number of individuals of adult lacewings (green/brown in the total column) captured in the agroecosystems according to different collection techniques. Abbreviations of species are *kolt*: *Chrysoperla kolthoffi*; *phyl*: *Chrysopa phyllochroma*; *carn*: *Chrysoperla carnea*; *perl*: *Chrysopa perla*; *flav*: *Dichochrysa flavifrons*; *albo*: *Cunctochrysa albolineata*; *vari*: *Micromus variegatus*; *angu*: *Micromus angulatus*; *hum*: *Hemerobius humulinus*; *lute*: *Hemerobius lutescens*

	kolt	phyl	carn	perl	flav	albo	vari	angu	hum	lute	Total
suction trap	86	1	7	–	3	2	–	–	–	–	99/0
vacuum	41	21	–	4	–	–	58	24	3	1	66/86
yellow traps	85	33	2	–	–	–	–	–	–	–	120/0
hand net	29	3	1	3	–	–	4	1	1	–	36/6
McPhail	–	–	–	–	–	–	–	–	–	–	0/0
(other)	2	1	–	–	–	–	–	–	–	–	3/0
Total	243	59	10	7	3	2	62	25	4	1	324/92

DER *et al.* 1981). Only the first two chrysopid species were of numerical importance. The common green lacewing *Ch. kolthoffi* occurred in each sample. It was the absolutely dominant species in each case and in each habitat, constituting 75% of the green lacewings and 58% of all Neuroptera. It showed here once more its dominance and its character of eurytopic generalist predator in extramediterranean

Table 2. Number of individuals adult lacewings (green/brown in the total column) captured in the surveyed crops. Abbreviations as in Table 1

	kolt	phyl	carn	perl	vari	angu	hum	lute	Total
Trees									
apple tree	10		1	1	7		1		12/8
Shrubs									
hop	1								1/0
hedges	1								1/0
Arable crops									
witloof	56	27							83/0
potato	31	27	2		4				60/4
strawberry	31			3	29	17	1	1	34/48
kidney-bean	12	1			22	8	2		13/32
tobacco	6	1							7/0
maize	5								5/0
lettuce	2	1							3/0
Weeds	4			2					6/0
Total	159	57	3	6	62	25	4	1	225/92

Table 3. Number of individuals of green lacewings established, i.e. issuing from eggs, larvae and cocoons, collected in the surveyed crops. Abbreviations as in Table 1

	kolt	carn	luca	phyl	perl	Total
Tree: apple tree	54	10			1	65
Arable crops: potato	14			23		37
strawberry	131		7	3		141
cabbage and carrot	13			7		20
Total	212	10	7	33	1	263

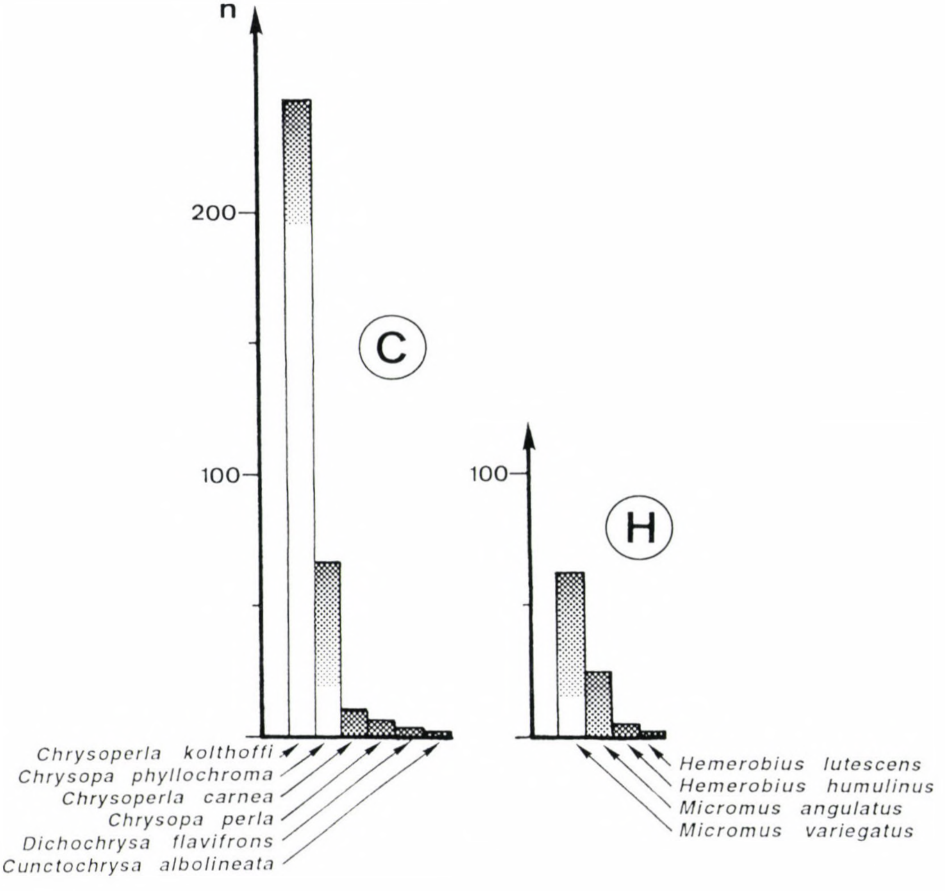


Fig. 1. Total number of individuals of adult chrysopids (C) and hemerobiids (H) collected in agroecosystems (data derived by cumulating all collecting methods)

Europe (THIERRY *et al.* 1996). On the contrary, *Ch. phyllochroma* (18% of the chrysopids and 14% of the Neuroptera) only occurred in yellow traps and in the vacuum collections, in the low and thick crops like witloof and potato. These captures agree with previous literature data reporting *Ch. phyllochroma* associated with intensively cultivated vegetation, root and fodder crops, and meadows (STELZL & DEVETAK 1999). It can be surprising that a closely related species, *Chrysopa commata* KIS et ÚJHELYI, 1965, has not been found in the chrysopid assemblage, though it has been recorded in France (LERAUT 1988) and it is more widespread and more common than *Ch. phyllochroma* in UK (PLANT 1994). However, surprisingly, a few individuals of *Ch. commata* were identified among the adult lacewings rearded from eggs and larvae collected in the crops (see below).

The brown lacewings represented only 22% of the total number of Neuroptera collected. They belonged to four species, in decreasing order of relative abundance: *Micromus variegatus* (FABRICIUS, 1793), *M. angulatus* (STEPHENS, 1836), *Hemerobius humulinus* LINNAEUS, 1758, *H. lutescens* FABRICIUS, 1793 (Fig. 1).

All of them are widespread eurytopic species. Only the two *Micromus* spp. are abundant, constituting 95% of the brown lacewings ; they are known as regular predators in crops, common in northwestern and Central Europe and considered associated with Euro-Siberian herbaceous vegetation (MONSERRAT & MARÍN 1996, SZENTKIRÁLYI 1997). The hemerobiids were collected only by vacuum and hand net, they did not enter either the yellow traps, the McPhail traps, or the (too high?) suction trap (Table 1). They were abundant on strawberry and kidney-bean fields where they superseded even green lacewings, but they were only sporadically present on the other crops.

Phenology of lacewings

The seasonal distribution of adult lacewing flight in the crops are shown in Fig. 2. One can see that some chrysopids and hemerobiids appeared in the beginning of May, representing the first spring generation (*Chrysopa perla, Micromus* spp.) and the remaining overwintering adults of *Chrysoperla*. The actual flight of the lacewings occurred mainly in July and lasted up to the middle (chrysopids) or the end (hemerobiids) of August. Later the brown lacewings totally disappeared, and the common green lacewings remained constantly present in low numbers as a consequence of their proper way to overwinter as adults in reproductive diapause. Concerning the voltinism of *Ch. phyllochroma*, the encountered population showed an heterogeneous life-history strategy: Among the eggs collected in June and the relative larvae weaving cocoons on mid-July, some individuals entered

diapause directly until the next spring to resume their development and to emerge as adults. They must constitute a univoltine strain. Others manifest a multivoltine capability, giving rise to a summer brood, the adults of which were found in the field up to the autumn. Such a strategy is known in some Palaearctic *Chrysopa* (PRINCIPI 1992).

The established green lacewing species

A total of 357 Neuroptera were collected on the plants as preimaginal instars, in which there were four hemerobiid larvae. For estimating the actual consistency of chrysopid predatory activity, we tried to rear the specimens of green lacewings, namely 187 eggs, 47 larvae and 29 cocoons. The results are reported in Table 3 and

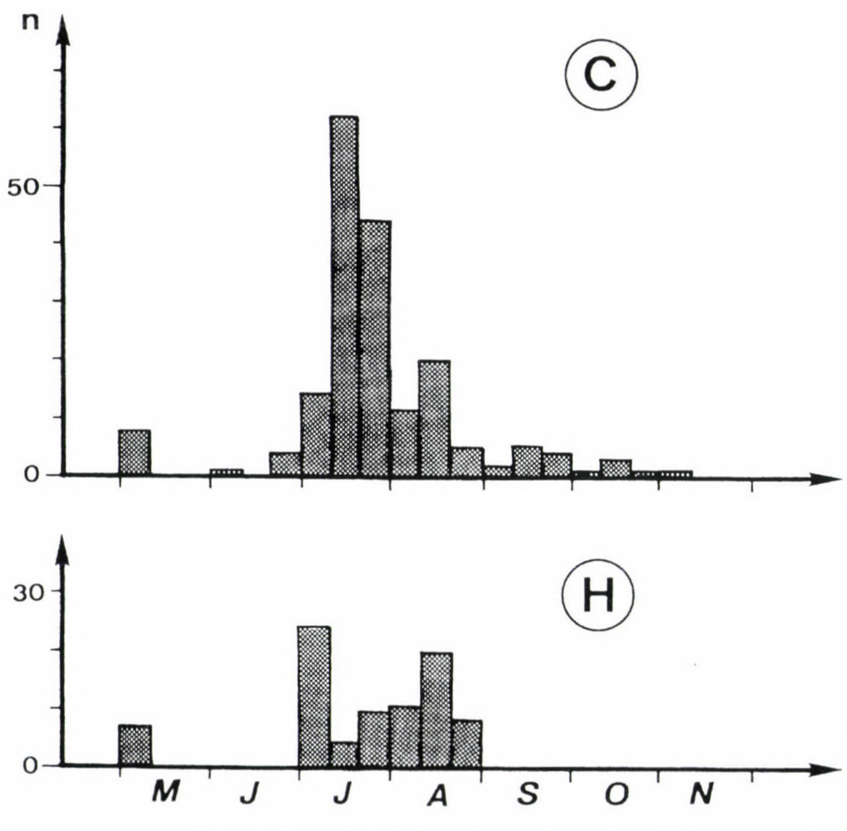


Fig. 2. Number of individuals of the collected adult chrysopids (C) and hemerobiids (H) in the sampled crops taken as a function of time

in Figure 3. A total of 263 specimens collected randomly gave rise in the insectarium to adults which have been identified as *Ch. kolhoffi*, *Ch. carnea*, *Ch. phyllochroma*, *Ch. commata*, *Ch. lucasina* and *Ch. perla*.

Twelve specimens did not develop directly to adults, but required several months to resume morphological development after winter (outside) diapause; all of them were *Ch. phyllochroma* emerging in oudoors rearing from the end of January to the middle of May.

Eggs and larvae of the common green lacewing are here also strongly dominant constituting 87% of the total chrysopid sample of established species. Within the *Chrysoperla carnea*-complex, *Chrysoperla kolthoffi* was the main species. Three peaks of occurrence appeared in mid May, at the beginning of June and at the end of July (Fig. 3) suggesting that three generations may develop. *Chrysoperla carnea* sensu stricto developed only on apple trees, in accordance with its

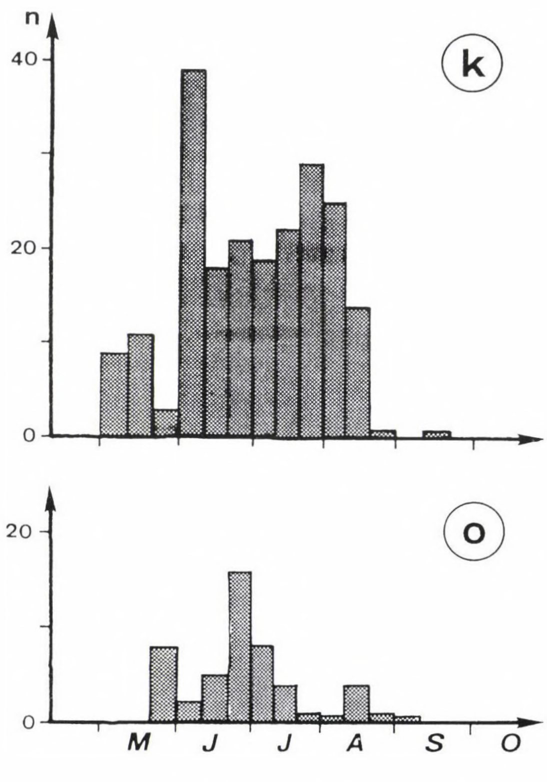


Fig. 3. Total number of individuals of chrysopid preimaginal instars recorded at actual or estimated date of egg deposition, collected in surveyed crops. K = *Chrysoperla kolthoffi*, O = other species

known ecological (arboreal) habits, whilst *Ch. lucasina* was found only on strawberry as expected with respect to its climatical and ecological (low stratum inhabiting) habits (THIERRY & CLOUPEAU, unpublished data). The possible occurrence of *Ch. commata* as an established species on potato opens a problem because all specimens of this group-species recorded as adults were identified as *Ch. phyllochroma*, despite fluctuating coloration characters of the head markings which are known in these allied species (SZIRÁKI 1994 and in lit.). We collected specimens showing either none or one (or more) of the following characters: post-ocular black spots, two or four post-occipital black spots, a light grey shade on the internal face of the scapes. However, some *Chrysopa* adults obtained after rearing in the insectarium and so coming from eggs collected on potato are undoubtedly referable to *commata* with respect to the gonocristae, but lacking of the typical black spot on internal face of the scapes.

Concerning mortality in the field, egg parasitization was commonly recorded in every crop, due to the embryonic parasitoid *Telenomus acrobates* Giard. For further parasitization, only two specimens of the pupal parasitoids *Dichrogaster* sp. emerged from the cocoons. However, the working method – sampling of eggs rather than older instars – is evidently unpropitious for the collection of pupal parasitoids which commonly infest either the second and/or third instar larvae or the prepupae and/or pupae within the cocoon (ALROUECHDI *et al.* 1984).

Biodiversity indices

Neuroptera are valuable indicators for assessing ecological statement of an habitat (STELZL & DEVETAK 1999). The taxonomic abundance of adult chrysopid recorded S = 6 was reduced and the related biodiversity was weak as attested by the Shannon's diversity index H' = 1.14. Many green lacewings, either rare or even common, have ecological requirements incompatible with modern farming systems. Consequently, (i) the lacewing assemblage appeared to be truncated (Fig. 1), (ii) the quantitative distribution of the remaining species seemed to be rather well-balanced, as attested by the Simpson's dominance $\lambda = 0.61$ and the McIntosh's diversity $D(MI) = 0.4$ indices. In comparison, an agropastoral system situated near Millau in southern France showed a much more diversified chrysopid assemblage. These biotopes slightly influenced by human activity, harboured 12 chrysopid species and gave evidence of a high biodiversity: H'=2.76; λ=0.17; $D(MI)$ = 0.62 (THIERRY *et al.* 2001).

CONCLUSION

In the investigated crops, the number of lacewing individuals were high enough, as to help in controlling arthropod pests such as aphids and caterpillars. However, the impoverished species diversity showed that the agricultural area has been perturbed by some cultural practices and intake of chemicals, and consequently, hazardous with respect to the auxiliary fauna. The modern mechanized farming often involving removal of hedges together with a long pesticide pressure is probably a cause for such a low biodiversity. Restoration of a bocage-type landscape, improved mastership of chemical pest control, use of biocontrol methods by farmers remain priority aims to promote safe agricultural production and to avoid aggressive interference with natural environment.

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RESOURCES IN SCOTTISH NEUROPTEROLOGY

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The Neuroptera collections of the National Museums of Scotland are hitherto an unexplored resource. Some records based on specimens exist, scattered through the British literature in small reports and citations, amalgamated into mapping exercises or are part of short papers describing new species. It is the purpose of this paper to outline the content of the collections and associated data sources.

Specimens, and labels directly associated with them, are the primary source of data. Most specimens are pinned in traditional entomological drawers. A smaller quantity of material exists in Industrial Methylated Spirits (70% IMS) with a much smaller quantity (a few species) in 70% Ethanol.

The secondary, but no less important, source of information exists in a database called the Scottish Insect Records Index (SIRI). This is a paper database of the citations for published Scottish Insect records – a key link to the British literature. The Neuroptera Records from this index are now being electronically databased.

From these data sources, we can establish how many specimens exist in which species and from what locations. Thus, informed answers to environmental and conservation questions can be supplied, and we can determine where further research is required.

Keywords: Megaloptera, Neuroptera, Raphidioptera

INTRODUCTION

The natural history collections of the National Museums of Scotland have their origins as early as 1812, due largely to the efforts of Professor ROBERT JAMESON (STEPHEN 1954, SWINNEY & SHAW 1998). At this time the Natural History specimens formed a museum collection belonging to the University of Edinburgh, but was combined (in 1855) with the cultural and technological displays of the then recently formed Industrial Museum of Scotland (ALLAN 1954, SWINNEY & SHAW 1998). In 1864 the combined body of collections took on the name "Edinburgh Museum of Science and Art" and in the jubilee year (1904) the name was again changed to the "Royal Scottish Museum" (ALLAN 1954). As a consequence of a change in policy (formation of a Board of Trustees in 1985 – SWINNEY & SHAW 1998), together with the recent opening of the "Museum of Scotland" (predominantly a museum of Scottish artefacts), on an adjacent site, the name was again changed to the "Royal Museum" under the umbrella organisation of the "National Museums of Scotland".

The Neuropterida collections are thus part of a much broader accumulation of specimens and artefacts, that included insect material from these earliest of times. In 1819 the renowned Dufresne Collection was purchased from Paris containing (among other natural history specimens) 12 000 insects (STEPHEN 1954) and it is to this collection that the earliest neuropterid specimen can be traced.

The insect collections have since grown, to now include approximately a million specimens, of which about 10 000 are Neuropterida, pinned and housed in 166 wooden drawers. There are also numerous store-boxes – some of which are wooden, the remainder are firm cardboard – containing material still in the process of being sorted.

The Neuropterida collection contains 19 families, 184 genera and 502 species, from a geographical range of 64 countries. The majority of specimens have been determined and sorted by five individuals: P. H. GRIMSHAW, K. J. MORTON, A. R. WATERSTON, C. W. PLANT and A. E. WHITTINGTON. Many specimens lack det. labels, but are placed under particular names in the collection (presumably by GRIMSHAW and WATERSON). During his term of office as Curator (1893–1930) and later Keeper (1930–1935), the insect collections were invigorated and rejuvenated by PERCY H. GRIMSHAW (1869–1939), who was fundamentally a dipterist. The Neuropterida collections (plus Odonata, Plecoptera and Trichoptera), grew dramatically with the presentation of K. J. MORTON's collection in 1940. With receipt of this bequest, RODGER WATERSON took on the considerable task of re-curating and organising the collection, incorporating material previously included in the general Entomology collection. He began by re-organising the Odonata and had started on the Neuroptera, but not finished before his retirement. Through his prior contacts with personnel in the Anti-Locust operations in the Middle East, these collections were to grow once more. He actively encouraged KEN GUICHARD (among others) to donate large quantities of material to the collections. Most of the strengths of the collection are based on the material contributed by MORTON and GUICHARD.

Recent loan records indicate that, hitherto, this is a largely underused resource. Documentation, cataloguing and curation of the collection has highlighted the fact that outside of these activities, the collection has received little international attention. And yet it is a collection drawn from a wide geographical context, covering taxa of extensive research interest. It is the purpose of this paper to outline what is available in the collections and associated data sources in the hope that this will encourage their use.

The primary source of data is the specimens and the labels directly associated with them. The vast majority of specimens are pinned in traditional entomological drawers. Presently the British material is pinned in 29 drawers separate from the

material from other parts of the World and this material is predominantly Scottish in origin. A smaller quantity of material exists in Industrial Methylated Spirits (70% IMS) with a much smaller quantity (a few species) in 70% Ethanol. Some dissected material exists on microscope slides, but this has yet to be assessed and catalogued. Label data from this primary source is being accumulated in a database.

At the family level, the collections show a healthy total of 19 out of 22 possible families (OSWALD & PENNY 1991), only the families Ithonidae, Rapismatidae and Rhachiberothidae are not represented.

At the generic and species levels, representation in the collections is poorer. There are 191 out of approximately 1000 genera and 547 out of more than 4000 species (OSWALD & PENNY 1991), with large numbers of world taxa not represented and there are obvious geographical strengths and limitations. The taxa currently present are listed in Appendix 1, while Figure 1 shows how many species originate from the upper range of countries listed in Appendix 2. All countries for

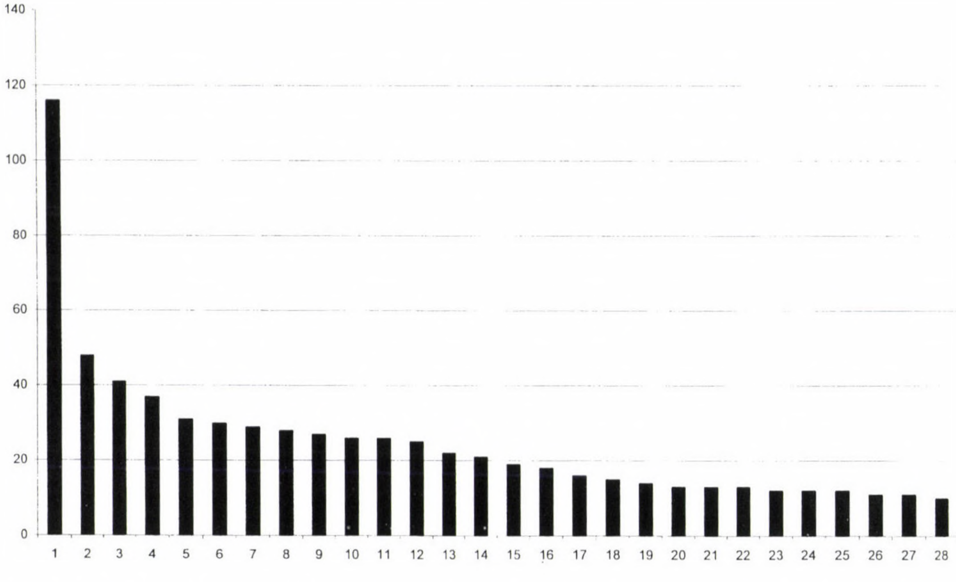


Fig. 1. Number of species per country from which Neuropterida specimens in National Museums of Scotland originate. Countries: 1 = Europe; 2 = Tanzania; 3 = Nigeria; 4 = Saudi Arabia; 5 = Israel; 6 = India; 7 = Zimbabwe; 8 = Turkey; 9 = Kenya; 10 = USA; 11 = S. Africa; 12 = Madagascar; 13 = Oman; 14 = Australia; 15 = W. Pacific Fringe; 16 = Yemen; 17 = Algeria; 18 = Niger; 19 = Malawi; 20 = Ghana; 21 = Pakistan; 22 = Sudan; 23 = China; 24 = Socotra; 25 = Morocco; 26 = UAE; 27 = Zambia; 28 = the rest (37 countries; number of species 10 or fewer)

which there are fewer than 10 species represented, have been accumulated into the last category of Figure 1.

The secondary, but no less important, source of information exists in the form of databases. In a parochial Scottish sense, a database called the Scottish Insect Records Index (SIRI) is highly valuable, but little used outside of Scotland. This is a paper database of the citations for published Scottish Insect records and is a key link to the British literature (SHAW 1987). PERCY GRIMSHAW began this database on cards, which were later transcribed in the files now comprising SIRI. The 628 Neuropterida Records from this Index are now being electronically databased, so as to improve access and make complex searches possible.

A specimen database is being developed as an important part of curation of the collections and also because SIRI is limited to published records, while data from large portions of the collection have not been published. This database presently holds only 228 data records taken from labels accompanying specimens. It does, however, also include the basic list of the species and their geographic provenance (Appendix 1 & 2).

EXPECTED RESULTS

The Neuropterida collections have been largely dormant since RODGER WATERSTON retired in 1977 (SHAW & GIBSON 1997). This project is intended to renew research interest in the Neuropterida collections in the National Museums of Scotland. From these primary and secondary sources of data, we can establish how many specimens exist in which species and from what locations. Thus, apart from supplying informed answers to environmental and conservation questions, we can establish on which species and which geographical areas further research is required. Ultimately a synoptic analysis of the Scottish fauna will be developed, to encapsulate the data into a single document.

National Museums of Scotland has also received requests for lists of the taxa at particular locations for the furtherance of both environmental and taxonomic research, both in Scotland and abroad. Thus, the provision of detailed databases of the material held in the collections will not only facilitate answers to these questions and make it easier to provided them, but it is hoped they will lead to greater awareness of what is in the collections and hence greater international use of them.

*

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APPENDIX 1

Neuropterida present in the National Museums of Scotland. Taxa are arranged alphabetically within each rank and only the ranks Family, Genus (in some cases subgenus) and species have been listed. Taxa and authorities at the species, generic and family levels, follow ASPÖCK *et al.* (1980), ASPÖCK *et al.* (1991), BROOKS and BARNARD (1990), CONTRERAS-RAMOS (1999), LINSLEY and USINGER (1966), MEINANDER (1972), NEW (1996), OSWALD and PENNY (1991) and TILLYARD (1923). Data for the United Kingdom (UK) are further broken down to the constituent countries England (E), Scotland (S) and Wales (W) and those for the United States of America (USA) are divided into the constituent states.

MEGALOPTERA

Corydalidae

Archichauliodes VAN DER WEELE, 1909
dubitatus (WALKER, 1853) – New Zealand
Chauliodes LATREILLE, 1796
pectinicornis (LINNAEUS, 1763) – USA: N. Scotia, Virginia
Corydalus LATREILLE, 1802
affinis BURMEISTER, 1839 – Brazil
sp. – Venezuela
Neochauliodes VAN DER WEELE, 1909
sinenis (WALKER, 1853) – China (Yunnan)
Neurhermes NAVÁS, 1915
macalipennis GRAY, 1832 – Java
selysi (VAN DER WEELE, 1909) – India (Assam)
Nevromus RAMBUR, 1842
intimis MCLACHLAN, 1869 – India (Assam)
latratus MCLACHLAN, 1869 – India (Assam)
testaceus RAMBUR, 1842 – Borneo Sabah
Nigronia BANKS, 1908
fasciata (WALKER, 1853) – USA: Virginia
Parachauliodes VAN DER WEELE, 1909
japonicus (MCLACHLAN, 1867) – Japan

Sialidae

Sialis LATREILLE, 1802
fuliginosa PICTET, 1836 – Germany, UK: S
iola ROSS, 1937 – USA: Virginia
lutaria (LINNAEUS, 1758) – France, Norway, UK: E, S
sordida KLINGSTEDT, 1932 – Finland

RAPHIDIOPTERA

Inocelliidae

Fibla NAVÁS, 1915
Subgenus *Fibla* NAVÁS, 1915
maclachlani ALBARDA, 1891 – Algeria
Inocellia SCHNEIDER, 1843
crassicornis (SCHUMMEL, 1832) – Sweden

Raphidiidae

Agulla NAVÁS, 1914
Subgenus *Agulla* NAVÁS, 1914
assimilis (ALBARDA, 1891) – USA: Oregon
Atlantoraphidia ASPÖCK et ASPÖCK, 1968
maculicollis STEPHENS, 1836 – France, Holland, UK: E, S
Dichrostigma NAVÁS, 1909
flavipes STEIN, 1836 – Germany
Phaeostigma NAVÁS, 1909
Subgenus *Phaeostigma* NAVÁS, 1909
notata (FABRICIUS, 1781) – Germany, UK: E
Puncha NAVÁS, 1915
ratzeburgi (BRAUER, 1876) – Germany
Raphidia LINNAEUS, 1758
Subgenus *Raphidia* LINNAEUS, 1758
ophiosis LINNAEUS, 1758 – Germany
Subilla NAVÁS, 1916
confinis (STEPHENS, 1836) – UK: E, S
Xanthostigma NAVÁS, 1909
xanthostigma SCHUMMEL, 1832 – Norway, UK: E

NEUROPTERA
Ascalaphidae

Acheron LEFÈBVRE, 1842
trux (WALKER, 1853) – India (Assam), Taiwan
Agrionosoma VAN DER WEELE, 1909
dohrni VAN DER WEELE, 1909 – India
swinhoei VAN DER WEELE, 1909 – India ("Punji")
Allocormodes MCLACHLAN, 1891
intractabilis (WALKER, 1860) – Nigeria
kolbei VAN DER WEELE, 1909 – Tanzania
maculipennis (TASCHENBERG, 1879) – Ghana
Ameropterus ESBEN-PETERSEN, 1922
delicatulus (MCLACHLAN, 1871) – Guyana
mortoni ESBEN-PETERSEN, 1933 – Trinidad
Ascalaphus FABRICIUS, 1775
abdominalis (KIMMINS, 1949) – W. Pakistan
aethiopicus (KIMMINS, 1949) – Tanzania
dicax WALKER, 1853 – Bengal, Iraq, W. Pakistan
festivus (REMBUR, 1842) – Israel, N. Nigeria, S. Arabia, Tanzania
worthingtoni (KIMMINS, 1949) – Ghana, W. Nigeria
spp. – Ghana, India, Kenya, Niger, Oman, Palestine, S. Africa, S. Arabia, S. Morocco, Socotra, Tanzania, Yemen
Ascalohybris SZIRÁKI, 1998
angulatus (WESTWOOD, 1848) – India (Assam)
borneensis (VAN DER WEELE, 1904) – Borneo, Brunei, Sabah
javana (BURMEISTER, 1839) – Java
subjacens (WALKER, 1853) – Japan
Ascalobyas PENNY, 1981
microcerus (RAMBUR, 1842) – Trinidad
sp. – India
Ascalorphne BANKS, 1915
impavidus (WALKER, 1853) – Brazil
Balanopteryx KARSCH, 1889
locuples KARSCH, 1889 – Madagascar
Brevibarbis TJEDER & HANSSON, 1992
argyropterus (TASCHENBERG, 1879) – Tanzania
Bubopsis MCLACHLAN, 1898
agrioides (RAMBUR, 1838) – Portugal, Spain
hamata (KLUG, 1834) – Oman, Palestine
tancrei VAN DER WEELE, 1909 – W. Pakistan
Cordulecerus RAMBUR, 1842
alopecinus (BURMEISTER, 1839) – Brazil
elegans VAN DER WEELE, 1909 – French Guyana
surinamensis (FABRICIUS, 1798) – Peru
Cormodophlebia VAN DER WEELE, 1909
pulchra VAN DER WEELE, 1909 – Madagascar
Deleproctophylla LEFÈBVRE, 1842
australis (FABRICIUS, 1787) – Greece, Sicily, Turkey
dusmeti (NAVÁS, 1914) – Spain, France
gelini (NAVÁS, 1919) – S. Morocco
variegata (KLUG, 1834) – Turkey ("Uardin" + "Kirikhan-Hassa Road")
Dicolpus GERSTAECKER, 1884
volucris GERSTAECKER, 1884 – no data
Disparomitus VAN DER WEELE, 1909
citernii NAVÁS, 1915 – Mozambique
horvathi VAN DER WEELE, 1909 –Tanzania
longus NAVÁS, 1911 – Tanzania
transvaaliensis VAN DER WEELE, 1909 – Tanzania
spp. det. TJEDER – Tanzania, Zimbabwe
Dixonotus KIMMINS, 1950
vansomereni KIMMINS, 1950 – Kenya
Encyoposis MCLACHLAN, 1873
bilineatus KOLBE, 1897 – Tanzania
hemichroa NAVÁS, 1913 – Malawi, Tanzania, Zimbabwe
hemistigma VAN DER WEELE, 1909 – Sudan
Eremophanes BANKS, 1924
bicristatus BANKS, 1924 – Zimbabwe
Glyptobasis MCLACHLAN, 1873
dentifera (WESTWOOD, 1848) – India
Idricerus MCLACHLAN, 1873
sogdianus MCLACHLAN, 1875 – Iran ("Sumarkand")
Libelloides Schäffer, 1763
baeticus (RAMBUR, 1838) – Spain
coccajus (DENIS et SCHIFFERMÜLLER, 1775) – France, Sicily, Spain, Switzerland
hispanicus (RAMBUR, 1842) – Spain

ictericus (CHARPENTIER, 1825) – Algeria, Corsica, Morocco, Sicily
italicus (FABRICIUS, 1781) – Italy, (Iraq?)
longicornis (LINNAEUS, 1764) – France, Spain
macaronius (SCOPOLI, 1763) – Bulgaria, Germany Greece, Turkey, Yugoslavia
ottomanus (GERMAR, 1839) – Greece, Turkey
ramburi (MCLACHLAN, 1875) – Japan
rhomboideus (SCHNEIDER, 1845) – Crete, Turkey
Neohaploglenius PENNY, 1982
flavicornis MCLACHLAN, 1871 – French Guyana
Nephoneura MCLACHLAN, 1873
costalis VAN DER WEELE, 1909 – Zimbabwe
Ogcogaster WESTWOOD, 1848
segmentator (WESTWOOD, 1847) – India
tessellata WESTWOOD, 1848 – W. Pakistan
Phalascusa KOLBE, 1897
braueri VAN DER WEELE, 1909 – Zambia
hilderbrandti KOLBE, 1897 – Zambia
Proctarrelabris LEFÈBVRE, 1842
capensis (THUNBERG, 1784) – S. Africa
involvens (WALKER, 1853) – S. Africa
Protidricerus VAN DER WEELE, 1909
exitis (MCLACHLAN, 1894) – China (Yunnan)
Protobubopsis VAN DER WEELE, 1909
braueri VAN DER WEELE, 1909 – Saudi Arabia, W. Pakistan
Ptyngidricerus VAN DER WEELE, 1909
albardanus (MCLACHLAN, 1891) – Oman
venustus TJEDER et WATERSTON, 1976 – Oman
Stephanolasca VAN DER WEELE, 1909
rufopicta (WALKER, 1853) – Niger, Nigeria
Stilbopteryx NEWMAN, 1838
costalis NEWMAN, 1838 – Australia
Suhpalacsa LEFÈBVRE, 1842
abdominalis MCLACHLAN, 1871 – Tanzania
lemoulti LACROIX, 1925 – Oman
principes GERSTAECKER, 1894 – no data
rutila (GERSTAECKER, 1894) – Tanzania
sp. – Australia
Suphalomitus VAN DER WEELE, 1909
buyssoni VAN DER WEELE, 1909 – Mozambique, Kenya
cephalotes (MCLACHLAN, 1871) – Madagascar
Tmesibasis MCLACHLAN, 1873
lacerata HAGEN, 1853 – Tanzania, Zambia, Zimbabwe
rothschildii VAN DER WEELE, 1907 – Kenya
spp. – E. Nigeria, Zimbabwe
Ululodes CURRIE, 1899
hyalinus (LATREILLE, 1811) – Peru
macleayana (GUILDING, 1825) – Trinidad
quadripuctata (BURMEISTER, 1838) – USA: Virginia
sp. – Columbia?

Berothidae

Lomamyia BANKS, 1904
banksi CARPENTER, 1940 – USA: Virginia
flavicornis (WALKER, 1853) – USA: Virginia
Mucroberotha TJEDER, 1959
nigrescens TJEDER, 1968 – Tanzania

Chrysopidae

Atlantochrysa HÖLZEL, 1970
atlantica (MCLACHLAN, 1882) – Canary Islands
Ceraeochrysa ADAMS, 1982
lineaticornis (FITCH, 1855) – USA: Virginia
Chrysopa LEACH, 1815
abbreviata CURTIS, 1834 – France, Romania, Spain, UK: E
dorsalis BURMEISTER, 1839 – France, UK: E
flaviceps (BRULLÉ, 1840) – Canary Islands
incompleta BANKS, 1911 – USA: Virginia
oculata SAY, 1839 – USA: Virginia
pallens (RAMBUR, 1838) – China, India, Japan, UK: E
perla (LINNAEUS, 1758) – Austria, Belgium, France, Germany, Hungary, Italy, Norway, Switzerland, Turkey, UK: E, S
phyllochroma WESMAEL, 1841 – Finland, Germany, Hungary, Norway
quadripunctata BURMEISTER, 1839 – USA: Virginia
sp. – Malawi

Chrysoperla STEINMANN, 1964
carnea (STEPHENS, 1836) – Canary Islands, Egypt, France, Germany, Hungary, India, Iraq, Italy, Spain, UK: E, S
congrua (WALKER, 1853) – S. Africa
externa externa (HAGEN, 1861) – Guatemala
rufilabris (BURMEISTER, 1839) – USA: Virginia
Chrysopidia NAVÁS, 1910
Subgenus *Chrysotropia* NAVÁS, 1911
ciliata (WESMAEL, 1841) – Belgium, Hungary, Ireland, UK: E, S, W
Chrysopodes NAVÁS, 1913
Subgenus *Neosuarius* ADAMS et PENNY, 1987
nigripilosa (BANKS, 1924) – Galapagos
porterina (NAVÁS, 1910) – Chile
varicosus NAVÁS, 1914 – West Pacific Fringe
Cunctochrysa HÖLZEL, 1970
albolineata (KILLINGTON, 1935) – UK: E, S
Dichochrysa YANG & YANG, 1990
flavifrons (BRAUER, 1850) – France, Italy, Spain, UK: E, W
genei (RAMBUR, 1842) – Israel
prasina (BURMEISTER, 1839) – France, Hungary, Ireland, Spain, Switzerland, UK: E, W
venosa (RAMBUR, 1842) – France, Israel, Spain, Switzerland
ventralis (CUTIS, 1834) – Czech, France, Hungary, Italy, Norway, Spain, UK: E, S, W
Glenochrysa ESBEN-PETERSEN, 1920
typica ESBEN-PETERSEN, 1920 – Ghana
Gonzaga NAVÁS, 1913
nigriceps (MCLACHLAN, 1867) – Peru
Italochrysa PRINCIPI, 1946
italica (ROSSi, 1790) – France, Italy, Majorca
oberthuri (NAVÁS, 1908) – China
stigmatica (RAMBUR, 1842) – Algeria, Spain
variegata (BURMEISTER, 1839) – Israel
Lainius NAVÁS, 1913
constellatus NAVÁS, 1913 – Guatemala
Leucochrysa MCLACHLAN, 1868
Subgenus *Leucochrysa* MCLACHLAN, 1868
clara (MCLACHLAN, 1867) – West Pacific Fringe
insularis (WALKER, 1853) – USA: Virginia
varia (SCHNEIDER, 1851) – West Pacific Fringe
Subgenus *Nodita* NAVÁS, 1916
azevedoi (NAVÁS, 1913) – Peru
postica (NAVÁS, 1913) – Peru
sp. – Brazil
Mallada NAVÁS, 1925
picteti (MCLACHLAN, 1882) – Monaco, Spain
punctilabris (MCLACHLAN, 1894) – China
subcostalis (MCLACHLAN, 1882) – Canary Islands
Nineta NAVÁS, 1912
flava (SCOPOLI, 1763) – Ireland, UK: E, S, W
guardarramensis (PICTET, 1865) – Hungary
vittata (WESMAEL, 1841) – Europe, UK: E, S
Nothochrysa MCLACHLAN, 1868
capitata (FABRICIUS, 1793) – UK: E, S
fulviceps (STEPHENS, 1836) – France, Hungary, Spain
sp. – Yemen
Retipenna BROOKS, 1986
dasyphlebia (MCLACHLAN, 1894) – China
notata (NAVÁS, 1910) – China
Suarius NAVÁS, 1914
lucasi (NAVÁS, 1910) – Iraq, Israel
tigridis (MORTON, 1921) – Israel

Coniopterygidae

Coniopteryx CURTIS, 1834
Subgenus *Coniopteryx* CURTIS, 1834
borealis TJEDER, 1930 – UK: S
tineiformis CURTIS, 1834 – UK: S
Subgenus *Metaconiopteryx* KIS, 1970
esbenpeterseni TJEDER, 1930 – UK: E
Conwentzia ENDERLEIN, 1905
pineticola ENDERLEIN, 1905 – UK: E, S
psociformis CURTIS, 1834 – Europe, Ireland, UK: E,S
Parasemidalis ENDERLEIN, 1905
fuscipennis (REUTER, 1894) – no data
Semidalis ENDERLEIN, 1905
aleyrodiformis (STEPHENS, 1836) – UK: E
vicina (HAGEN, 1861) – USA: Virginia

Dilaridae

Dilar RAMBUR, 1838
meridionalis HAGEN, 1866 – Ireland, Spain

Hemerobiidae

Drepanacra TILLYARD, 1916
binocula NEWMAN, 1838 – Sulawesi
Drepanepteryx LEACH, 1815
algida (ERICHSON, 1851) – Austria, Switzerland
phalaenoides (LINNAEUS, 1758) – Germany, Norway, Switzerland, UK: E, S
Hemerobius LINNAEUS, 1758
Subgenus *Brauerobius* KRÜGER, 1922
marginatus STEPHENS, 1836 – Ireland, Norway, UK: S
Subgenus *Hemerobius* LINNAEUS, 1758
atrifrons MCLACHLAN, 1868 – Czech, France, Germany, Norway, UK: S, W
contumax TJEDER, 1932 – France
eatoni MORTON, 1906 – Canary Islands
fenestratus TJEDER, 1932 – Denmark
gilvus STEIN, 1863 – Hungary
humulinus LINNAEUS, 1758 – Austria, Czech, France, Germany, Hungary, Norway, Spain, UK: E, S, USA: Virginia
lutescens FABRICIUS, 1793 – Austria, Czech, France, Hungary, Ireland, UK: E, S
micans OLIVIER, 1792 – France, Hungary, Ireland, Yugoslavia, UK: S, W
nitidulus FABRICIUS, 1777 – Austria, Norway, UK: E, S
perelegans STEPHENS, 1836 – UK: S
pini STEPHENS, 1836 – France, Germany, Norway, Switzerland, UK: E, S
simulans WALKER, 1853 – Norway, Switzerland, UK: E, S
stigma STEPHENS, 1836 – Austria, Czech, France, Germany, Spain, UK: E, S, USA: Virginia
Megalomus RAMBUR, 1842
darwini BANKS, 1924 – Galapagos
fidelis (BANKS, 1897) – USA: Virginia
hirtus (LINNAEUS, 1761) – France, Spain, UK: S
Micromus RAMBUR, 1842
angulatus (STEPHENS, 1836) – France, Hungary, Ireland, Israel, Norway, Poland, UK: E
bifasciatus TILLYARD, 1923 – New Zealand
lanosus (ZELENÝ, 1962) – Hungary
paganus (LINNAEUS, 1767) – Ireland, Norway, UK: S, W
posticus (WALKER, 1853) – USA: Virginia
tasmaniae (WALKER, 1860) – New Zealand
variegatus (FABRICIUS, 1793) – France, Hungary, Ireland, UK: E, S
Psectra HAGEN, 1866
diptera (BURMEISTER, 1839) – UK: E
Sympherobius BANKS, 1904
amiculus (FITCH, 1855) – USA: Virginia
elegans (STEPHENS, 1836) – UK: E
fallax NAVÁS, 1908 – France, Israel
fuscescens (WALLENGREN, 1863) – Austria, Czech, Norway, UK: S
klapaleki ZELENÝ, 1963 – UK: E
pellucidus (WALKER, 1853) – UK: E
pygmaeus (RAMBUR, 1842) – Spain, UK: E
Wesmaelius KRÜGER, 1922
Subgenus *Kimminsia* KILLINGTON, 1937
malladai (NAVÁS, 1925) – France, Norway, Sweden, UK: S
nervosus (FABRICIUS, 1793) – France, Ireland, Norway, UK: E, S, W
navasi (ANDRÉU, 1911) – Israel
ravus (WITHYCOMBE, 1923) – UK: E
subnebulosus (STEPHENS, 1836) – France, Norway, UK: E, S, W
Subgenus *Wesmaelius* KRÜGER, 1922
concinnus (STEPHENS, 1836) – Czech, Poland, UK: E, S
quadrifasciatus (REUTER, 1894) – France, Switzerland, UK: E, S, W

Mantispidae

Mantispa ILLIGER, 1798
grandis ERICHSON, 1839 – S. Africa
nana (NAVÁS, 1912) – Saudi Arabia
styriaca (PODA, 1761) – Corsica, France
viridis WALKER, 1853 – USA: Virginia
spp. – India, New Guinea
Trichoscelia WESTWOOD, 1852
varia (WALKER, 1853) – no data

Myrmeleontidae

Acanthaclisis RAMBUR, 1842
baetica RAMBUR, 1842 – Italy, Spain

occitanica (VILLERS, 1789) – France, Hungary, Spain, Turkey
pallida (MCLACHLAN, 1887) – Iraq ("Amara"), Tigris
Ameromyia BANKS, 1913
muralli NAVÁS,1932 – Brazil
Bankisus NAVÁS, 1912
carinifrons (ESBEN-PETERSEN,1936) – Tanzania, Zimbabwe
oculatus NAVÁS, 1912 – Tanzania, Zimbabwe
Banyutus NAVÁS, 1912
indicus NAVÁS, 1929 – India
lethalis (WALKER, 1853) – Gabon, S. Africa, Zaïre, Zambia
leucospilos (HAGEN, 1853) – Malawi, Tanzania, Zaïre
roseostigma NAVÁS, 1914 – Tanzania
verendus (WALKER, 1853) – Sri Lanka
Brachynemurus HAGEN, 1888
ferox (WALKER, 1853) – USA: Arizona, Oregon, Utah
mexicanum BANKS, 1895 – USA (New Mexico)
sp. – Brazil
Callistoleon BANKS, 1910
erythrocephalus (LEACH, 1814) – Australia
Campestretus NAVÁS, 1933
extraneus (NAVÁS, 1912) – Nigeria, Sudan, Tanzania
Centroclisis NAVÁS. 1909
brachygaster (RAMBUR, 1842) – Kenya, Tanzania, Zimbabwe
cervina (GERSTAECKER, 1863) – Egypt, Mauritania, Niger, Saudi Arabia, Yemen
distincta (RAMBUR, 1842) – Tanzania
felina (GERSTAECKER, 1894) – Niger, Tanzania
lineata (KIRBY, 1903) – Tanzania, Zanzibar
lineatipennis (PÉRINGUEY, 1910) – S. Africa
malitiosa (NAVÁS, 1912) – Malawi, Nigeria, Tanzania
punctulata NAVÁS, 1912 – Mauritania, Niger, Sudan, Yemen
rufescens (GERSTAECKER, 1885) – Ghana, Nigeria
vitanda (NAVÁS, 1912) – Saudi Arabia
spp. – India, S. Africa
Cosina NAVÁS, 1912
maclachlani (VAN DER WEELE, 1904) – Australia
Crambomorphus MCLACHLAN, 1867
grandidieri VAN DER WEELE, 1907 – Madagascar
Creoleon TILLYARD, 1918
aegyptiacus (RAMBUR, 1842) – Corsica, Spain
africanus (RAMBUR, 1842) – Ghana, Nigeria, Zambia
cinerascens (NAVÁS, 1912) – Algeria, Israel, Jordan, Oman, Saudi Arabia, Yemen
decusseta NAVÁS, 1914 – Kenya, Tanzania
diana (KOLBE, 1897) – Tanzania, Zimbabwe, Zambia
elegans HÖLZEL, 1968 – Iraq, Oman, Pakistan, UAE
griseus (KLUG, 1834) – Canary Islands, Egypt, Iraq, Israel, Oman, Sudan, UAE
litteratus (NAVÁS, 1908) – Madagascar
lugdunensis (VILLIERS, 1789) – Crete, France, Greece, Israel, Mallorca, Menorca, Morocco, Spain
mortifer (WALKER, 1853) – Kenya, Socotra, Sudan
nigritarsis NAVÁS, 1911 – S. Africa
nubifer (KOLBE, 1897) – Nigeria, Saudi Arabia, Tanzania, Uganda, Madagascar, Yemen
plumbeus (OLIVIER, 1811) – Algeria, France, Greece, Hungary, Iraq, Israel, Italy, Lebanon, Romania, Sardinia, Sicily, Spain, Turkey
spp. – Algeria, Ghana, Madagascar, Mauritania, Niger, Nigeria, Saudi Arabia
Cueta NAVÁS, 1911
externa NAVÁS, 1914 – Madagascar
klugi (HÖLZEL, 1982) – Kenya, Mauritania, Tanzania, Yemen
lineosa (RAMBUR, 1842) – Algeria, Bahrain, Greece, Israel, Morocco, Palestine,

Saudi Arabia, Turkey, W. Pakistan, Yemen
minervae HÖLZEL, 1972 – Oman
mysteriosa (GERSTAECKER, 1894) – Tanzania, Kenya
punctatissima (GERSTAECKER, 1894) – Malawi, Tanzania, N. Nigeria, Yemen?, Zambia
rimata (NAVÁS, 1912) – W. Nigeria
spp. – E. Africa, India, Oman, Saudi Arabia, Socotra
Cymothales GERSTAECKER, 1894
poultoni NAVÁS, 1913 – Malawi
mirabilis GERSTAECKER, 1894 – Tanzania
eccentros (WALKER, 1860) – S. Africa
Delfimeus NAVÁS, 1912
irroratus (OLIVIER, 1811) – Israel, Turkey, Yemen
Dendroleon BRAUER, 1866
pantherinus (FABRICUS, 1787) – Hungary
obsoletus (SAY, 1839) – USA: Virginia
Dimarella BANKS, 1913
praedator (WALKER, 1853) – Brazil
Distoleon BANKS, 1910
annulatus (KLUG, 1834) – Algeria
bistrigatus (RAMBUR, 1842) – Australia, Bengal
canariensis (TJEDER, 1939) – Canary Islands
crampeli (ESBEN-PETERSEN, 1933) – Nigeria
curdicus HÖLZEL, 1972 – Turkey
ilione (BANKS, 1911) – Kenya
laticollis (NAVÁS, 1913) – Israel
lynx (NAVÁS, 1912) – Nigeria
perlatus GERSTAECKER, 1885 – Kenya, Zimbabwe
pictiventris (NAVÁS, 1914) – Madagascar
quinquemaculatus (HAGEN, 1853) – Malawi, Nigeria, Zimbabwe
sanguinolentus (NAVÁS, 1912) – Nigeria
somnolentus (GERSTAECKER, 1885) – Australia
tetragrammicus (FABRICIUS, 1798) – Crete, France, Greece, Turkey
zonarius (NAVÁS, 1934) – Yemen
spp. – Kenya, Pakistan
Echthromyrmex MCLACHLAN, 1867
insularis KIMMINS, 1961 – Socotra
Euroleon ESBEN-PETERSEN, 1919
nostras (GEOFFROY, 1785) – Austria, Hungary, Italy, UK: E
Feinerus NAVÁS, 1919
umbratus NAVÁS, 1919 – China (Yunnan)
Froggattisca ESBEN-PETERSEN, 1915
longula (NAVÁS, 1926) – Palestine, Saudi Arabia
pulchella ESBEN-PETERSEN, 1915 – Australia
Galapagoleon STANGE, 1994
darwini STANGE, 1969 – Galápagos
Gandulus NAVÁS, 1912
sp. – Kenya, Nigeria, Zimbabwe
Ganguilus NAVÁS, 1912
pallescens NAVÁS, 1912 – Mauritania, Sudan
sp. – Morocco
Gatzara NAVÁS, 1915
jubilaea NAVÁS, 1915 – Darjeeling
Gepella HÖLZEL, 1968
modesta HÖLZEL, 1968 – Oman, Saudi Arabia
Gepus NAVÁS, 1912
buxtoni MORTON, 1921 – Iraq
curvatus NAVÁS, 1914 – Egypt, Oman, Palestine, Saudi Arabia
invisus NAVÁS, 1912 – Oman, Palestine, Saudi Arabia, Trucial States, Yemen
variegatus NAVÁS, 1932 – Saudi Arabia
Geyria ESBEN-PETERSEN, 1920
lepidula (NAVÁS, 1912) – UAE
Glenoleon BANKS, 1913
annulatus ESBEN-PETERSEN, 1918 – Australia
dissolutus (GERSTAECKER, 1885) – Australia
pulchellus (RAMBUR, 1842) – Australia (N.S.W)
Glenuroides OKAMOTO, 1910
japonicus MACLACHLAN, 1867 – Japan
Glenurus HAGEN, 1866
heteropteryx GERSTAECKER, 1885 – Trinidad
spp. – China (Yunnan), Philippines
Gymnocnemia SCHNEIDER, 1845
variegata (SCHNEIDER, 1845) – Sicily
Gymnoleon BANKS, 1911

dentatus NAVÁS, 1923 – Tanzania, Zambia
exilis BANKS, 1911 – Malawi
sp. – Algeria
Hagenomyia BANKS, 1911
guttata (NAVÁS, 1914) – Kenya, Tanzania
imperator (NAVÁS, 1914) – Nigeria
punctata (NAVÁS, 1911) – Israel, Kenya
sagax (WALKER, 1853) – Borneo, Hong Kong, Sabah
seyrigi (NAVÁS, 1933) – Madagascar
Heoclisis NAVÁS, 1923
fulvifusa (KIMMINS, 1939) – Australia
fundata (WALKER, 1853) – Australia
louiseae BANKS, 1938 – Philippines
sp. – India
Jaya NAVÁS, 1912
dasymalla (GERSTAECKER, 1863) – Kenya
Klapalekus NAVÁS, 1912
nubilatus NAVÁS, 1912 – Nigeria
sp. – Turkey
Lachlathetes NAVÁS, 1926
chiangi BANKS, 1941 – China (Yunnan)
moestus (HAGEN, 1853) – S. Africa, Tanzania, Zimbabwe
Layahima NAVÁS, 1912
nebulosa NAVÁS, 1912 – Darjeeling
Lopezus NAVÁS, 1913
fedtschenkoi MCLACHLAN, 1875 – Israel, Russia
Macroleon BANKS, 1909
lynceus (FABRICIUS, 1787) – Nigeria
polyzonus (GERSTAECKER, 1885) – Ghana
validus (MCLACHLAN, 1894) – Madagascar
Macronemurus A. COSTA, 1855
appendiculatus (LATREILLE, 1807) – Corsica, France, Italy, Malta, Morocco, Spain
bilineatus BRAUER, 1868 – Greece, Turkey
delicatulus MORTON, 1926 – Israel
elegantulus MACLACHLAN, 1898 – Tunisia
euanthe BANKS, 1911 – Tanzania, Uganda
linearis (KLUG, 1834) – Israel, Lebanon
striolus KOLBE, 1897 – Kenya, Tanzania
Maracanda MCLACHLAN, 1875
lineata NAVÁS, 1913 – Saudi Arabia
Megistopus RAMBUR, 1842
flavicornis (ROSSI, 1790) – Hungary, Morocco
Mesonemurus NAVÁS, 1920
harterti NAVÁS, 1920 – Jordan
steineri HÖLZEL, 1972 – Turkey
Mossega NAVÁS, 1914
indecisa (BANKS, 1913) – Australia
Myrmecaelurus A. COSTA, 1855
acerbus (WALKER, 1853) – Iraq ("Mesopotamia")
atomarius (RAMBUR, 1842) – Mauritania, Nigeria
lobatus NAVÁS, 1912 – Saudi Arabia
major MCLACHLAN, 1875 – Turkey
medius NAVÁS, 1913 – Sudan
persicus (NAVÁS, 1929) – Saudi Arabia, Trucial States, Yemen
peterseni KIMMINS, 1943 – Arabia
punctulatus (STEVEN in FISCHER v. WALDHEIM, 1822)
spectabilis NAVÁS, 1912 – N.W. Persia, Turkey
subcostatus BANKS, 1911 – Mauritania, Niger, Nigeria, Sudan
trigrammus (PALLAS, 1771) – Greece, Hungary, India, Italy, Jordan, Lebanon, Moldavia, N.W. Persia, Palestine, Saudi Arabia, Spain, Turkey, W. Pakistan, Yemen
tristis (WALKER, 1853) – Gabon, Kenya, Malawi, Nigeria, Sierra Leone, Tanzania, Zaïre, Zambia, Zimbabwe
varians NAVÁS, 1913 – Palestine
zigan H. ASPÖCK, U. ASPÖCK et HÖLZEL, 1980 – Hungary
sp. – Bengal
Myrmeleon LINNAEUS, 1767
acer WALKER, 1853 – Australia
alternans BRULLÉ, 1839 – Canary Islands, Socotra
atrox (WALKER, 1853) – Turkey
brasiliensis NAVÁS, 1914 – Brazil
celebensis MACLACHLAN, 1875 – Brunei
circumcinctus TJEDER, 1963 – Palestine
croceicollis GERSTAECKER, 1885 – Australia
crudelis WALKER, 1853 – USA: Virginia

doralice BANKS, 1911 – Israel, Kenya, Morocco, Oman (Dhufar), Palestine, Saudi Arabia, S. Africa, Trucial States, Turkey
formicarius LINNAEUS, 1767 – Denmark, France, Greece, Netherlands
hyalinus OLIVIER, 1811 – Algeria, Canary Islands, Oman
immaculatus DEGEER, 1773 – USA: Virginia
inconspicuus RAMBUR, 1842 – Austria, France, Hungary, Italy, Persia, Spain, Turkey
lentus (WALKER, 1853) – Malaya, Sabah
lethifer WALKER, 1853 – Kenya, Malawi, Tanzania, S. Africa, Zanzibar, Zimbabwe
obscurus RAMBUR, 1842 – Botswana, Ghana, Kenya, Nigeria, Madagascar, Tanzania
perpilosus BANKS, 1924 – Galapagos
pictifrons GERSTAECKER, 1885 – Australia
picturatus NAVÁS, 1914 – Nigeria
tenuipennis (RAMBUR, 1842) – India
torquatus NAVÁS, 1914 – Madagascar
trivialis GERSTAECKER, 1885 – Darjeeling
saevus WALKER, 1853 – S. China
sp. near *hyalinus* OLIVIER, 1871 – Saudi Arabia, Socotra

Nadus NAVÁS, 1935
sudanensis NAVÁS, 1935 – Kenya, Zimbabwe

Nannoleon ESBEN-PETERSEN, 1928
michaelseni ESBEN-PETERSEN, 1928 – S. Africa

Neleoma NAVÁS, 1914
spp. – Australia, Israel, Madagascar, Morocco, Socotra, Tanzania, Yemen

Nemoleon NAVÁS, 1909
alcidice BANKS, 1911 – S. Africa
filiformis (GERSTAECKER, 1885) – Malawi, S. Africa
latens NAVÁS, 1911 – India, W. Pakistan
notatus (RAMBUR, 1842) – Madagascar, Nigeria
sp. – Tanzania, Nigeria

Nesoleon BANKS, 1909
boschimanus (PÉRINGUEY, 1910) – S. Africa, Zimbabwe
trivirgatus (GERSTAECKER, 1885) – S. Africa, Zambia, Zimbabwe

Neuroleon NAVÁS, 1909
arenarius (NAVÁS, 1904) – Spain
basilineatus FRASER, 1952 – Madagascar
canariensis (NAVÁS, 1906) – Canary Islands, Tenerife
egenus (NAVÁS, 1914) – Spain
junior (NAVÁS, 1930) – Saudi Arabia
leptaleus (NAVÁS, 1912) – Algeria, Saudi Arabia
limbatellus NAVÁS, 1913 – Algeria
longipennis (ESBEN-PETERSEN, 1931) – Kenya, Oman
microstenus (MCLACHLAN, 1898) – Greece
nemausiensis (BORKHAUSEN, 1791) – France, Italy
ocreatus (NAVÁS, 1904) – France, Spain
parvus KIMMINS, 1943 – Saudi Arabia
taifensis KIMMINS, 1943 – Saudi Arabia
tenellus (KLUG, 1834) – Turkey, Israel, Morocco
torridus NAVÁS, 1914 – Tanzania
spp. – Ghana, Iran, Israel, Oman, Trucial States, Saudi Arabia,

Nohoveus NAVÁS, 1918
atrifrons (HÖLZEL, 1970) – Spain, Turkey
lepidus (KLUG, 1834) – Algeria, India, Saudi Arabia, Yemen, UAE
spp. – Mauritania, Saudi Arabia

Nophis NAVÁS, 1912
teillardi NAVÁS, 1912 – Mali, Saudi Arabia

Nosa NAVÁS, 1911
tigris (DALMAN, 1823) – Niger, Nigeria, Zimbabwe
tristis (HAGEN, 1853) – Central Africa, Kenya, Tanzania

Palpares RAMBUR, 1842
amitinus KOLBE, 1906 – Madagascar
angustus MCLACHLAN, 1898 – Mali, Saudi Arabia
astutus (WALKER, 1853) – India
berlandi NAVÁS, 1914 – Ghana
caffer (BURMEISTER, 1838) – S. Africa
cataractae PÉRINGUEY, 1910 – Nigeria, Tanzania, Zimbabwe

cephalotes (KLUG, 1834) – Niger, Saudi Arabia, Sudan, Trucial States
digitatus GERSTAECKER, 1894 – Nigeria
dispar NAVÁS, 1912 – Oman (Dhufar), Yemen
festivus (GERSTAECKER, 1894) – no data
flavofasciatus (MCLACHLAN, 1867) – Zimbabwe
furfuraceus (RAMBUR, 1842) – Niger, Nigeria
gattatus (NAVÁS, 1933) – Madagascar
geniculata NAVÁS, 1912 – Israel, Lebanon
gigas (DALMAN, 1832) – Sierra Leone
hildebrandti KOLBE, 1906 – Madagascar
inclemens (WALKER, 1853) – Socotra, S. Africa
incommodus (WALKER, 1853) – Nigeria
insularis MCLACHLAN, 1894 – Madagascar
klugi KOLBE, 1898 – Algeria, Niger, Saudi Arabia
latipennis RAMBUR, 1842 – Niger, Nigeria, Sudan
libelloides (LINNAEUS, 1767) – Algeria, Greece, France, Iran, Israel, Lebanon, Morocco, Palestine, Sicily, Spain, Turkey
longicornis (NAVÁS, 1912) – N. Nigeria
nyassanus (NAVÁS, 1911) – Malawi
obscuripennis (SCMIDT, 1907) – Zimbabwe
obsoletus GERSTAECKER, 1888 – Congo, Zaïre, Zimbabwe
papilionoides (KLUG, 1834) – Kenya, Niger, Saudi Arabia, Tanzania, Yemen
pardaloides (VAN DER WEELE, 1907) – Madagascar
pardus (RAMBUR, 1842) – Bengal, India
radiatus RAMBAR, 1842 – Mauritania
sobrinus PÉRINGUEY, 1911 – S. Africa
solidus GERSTAECKER, 1893 – Oman (Dhufar), W. Pakistan
sparsus HAGEN, 1887 – Kenya, Malawi, Tanzania, Zimbabwe
speciosus (LINNAEUS, 1758) – S. Africa
spectrum (RAMBUR, 1842) – Niger, Sudan
tessellatus (RAMBUR, 1842) – Algeria, Mali, Mauritania, Niger, Sudan
torridus NAVÁS,1912 – Ghana, Zimbabwe
trichogaster NAVÁS, 1913 – India
voeltzkowi (KOLBE, 1906) – Madagascar
walkeri MACLACHLAN, 1894 – Kenya, Saudi Arabia
zebratus RAMBAR, 1842 – W. Pakistan
sp. – India

Palparidius PÉRINGUEY, 1910
concinnus PÉRINGUEY, 1910 – Botswana, S. Africa

Pamexis HAGEN, 1866
luteus (THUNBERG, 1784) – S. Africa

Paraglenurus VAN DER WEELE, 1909
spp. – China (Yunnan), Rossel Island

Phanoclisis BANKS, 1913
longicollis (RAMBUR, 1842) – Mauritania, Nigeria, Saudi Arabia

Pseudoformicaleo VAN DER WEELE, 1909
nubeculus (GERSTAECKER, 1885) – Sabah

Quinemurus KIMMINS, 1943
cinereus KIMMINS, 1943 – Trucial States

Sogra NAVÁS, 1911
alluaudi (VAN DER WEELE, 1909) – Madagascar

Solter NAVÁS, 1912
felderi NAVÁS, 1912 – Israel
hardei HÖLZEL, 1968 – Saudi Arabia
ledereri NAVÁS, 1912 – Israel, Turkey
liber NAVÁS, 1912 – Portugal
virgilii NAVÁS, 1931 – Socotra
sp. – N. Nigeria

Stenares HAGEN, 1866
harpyia (GERSTAECKER, 1863) – India
hyaena (DALMAN, 1823) – Nigeria
improbus (WALKER, 1853) – India
irroratus NAVÁS, 1912 – Oman, Saudi Arabia
sp. near *irroratus* NAVÁS, 1912 – Israel

Stiphroneura GERSTAECKER, 1885
inclusa (WALKER, 1853) – India, Bengal

Syngenes KOLBE, 1897
arabicus KIMMINS, 1943 – Yemen
dolichocercus NAVÁS, 1914 – Madagascar
longicornis RAMBUR, 1842 – Zimbabwe
spp. – Nigeria, Socotra

Tomatares HAGEN, 1866
citrinus HAGEN, 1853 – S. Africa, Zimbabwe
clavicornis (LATREILLE, 1829) – Niger, Nigeria
limonius NAVÁS, 1912 – no data

pardalis (FABRICUS, 1781) – Darjeeling, India
striolatus (STITZ, 1912) – Sudan
Vella NAVÁS, 1913
fallax (RAMBUR, 1842) – N. America
Vessa NAVÁS, 1931
guttata NAVÁS, 1931 – Zambia
Voltor NAVÁS, 1935
sylphis (VAN DER WEELE, 1907) – Madagascar
Weeleus NAVÁS, 1912
acutus (WALKER, 1853) – New Zealand

Nemopteridae

Croce MCLACHLAN, 1885
alba (OLIVIER, 1811) – Israel
filipennis (WESTWOOD, 1841) – Bengal
sp. – Saudi Arabia
Dielocroce COWLEY, 1941
elegans (MARTYNOVA, 1930) – Oman
persica (MARTYNOVA, 1930) – Iran
Halter RAMBUR, 1842
halteratus (FORSKÅL, 1775) – Iraq ("Baiji"), Oman, Pakistan, Saudi Arabia, Trucial States
Josandreva NAVÁS, 1906
sazi NAVÁS, 1906 – Spain
spuria TJEDER, 1975 – Socotra
Lertha NAVÁS, 1910
barbara (KLUG, 1838) – unknown locality ("Marruecos")
extensa (OLIVIER, 1811) – Turkey
ledereri (SÉLYS-LONGCHAMPS, 1866) – Turkey
Nemeura NAVÁS, 1915
glauningi (KOLBE, 1901) – Tanzania, Zimbabwe
gracilis (HAGEN, 1886) – S. Africa
Nemopistha NAVÁS, 1910
imperatrix (WESTWOOD, 1867) – Ghana
togonica (KOLBE, 1900) – Nigeria
Nemoptera LATREILLE, 1802
aegyptiaca RAMBUR, 1842 – Israel
bipennis (ILLIGER, 1812) – Spain
coa (LINNAEUS, 1758) – Greece
sinuata OLIVIER, 1811 – Greece, Turkey
Parasicyoptera TJEDER, 1974
guichardi TJEDER, 1974 – Socotra

Nevrorthidae

Nevrorthus A. COSTA, 1863
fallax (RAMBUR, 1842) – Corsica
iridipennis A. COSTA, 1863 – Bulgaria

Nymphidae

Nymphes LEACH, 1814
myrmeleonoides LEACH, 1814 – Australia
Osmylops BANKS, 1913
armatus (MCLACHLAN, 1867) – Australia
sp. – New Guinea

Osmylidae

Kempynus NAVÁS, 1912
citrinus (MCLACHLAN, 1873) – New Zealand
incisus (MCLACHLAN, 1863) – New Zealand
Osmylus LATREILLE, 1802
fulvicephalus (SCOPOLI, 1763) – France, Germany, Italy, UK: E, S
Porismus MCLACHLAN, 1867
strigatus (BURMEISTER, 1838) – Australia
Thyridosmylus KRÜGER, 1913
minor KIMMINS, 1942 – Bengal

Polystoechotidae

Polystoechotes BURMEISTER, 1839
punctatus (FABRICIUS, 1793) – N. America

Psychopsidae

Psychopsis NEWMAN, 1842
notabilis NAVÁS, 1912 – Burma
Zygophlebius NAVÁS, 1910
zebra (BRAUER, 1889) – Malawi

Sisyridae

Sisyra BURMEISTER, 1839
brunnea BANKS, 1909 – Australia
dalii MCLACHLAN, 1866 – France, UK: W
fuscata (FABRICIUS, 1793) – France, Norway, UK: E, S
jutlandica ESBEN-PETERSEN, 1915 – Norway
terminalis CURTIS, 1854 – Czech, Hungary, Ireland, UK: E

APPENDIX 2

Countries of origin of the Neuropterida specimens in the National Museums of Scotland. Figures after the country indicate numbers of species per country in the orders Neuroptera+Megaloptera+Raphidioptera with the total for the three Orders in brackets.

Algeria 15+0+1 (16)
Australia 21+0+0 (21)
Bahrain 1+0+0 (1)
Bengal 7+0+0 (7)
Botswana 2+0+0 (2)
Brazil 7+1+0 (8)
Canary Islands 10+0+0 (10)
Central African Republic 1+0+0 (1)
Central America 2+0+0 (2)
Chile 1+0+0 (1)
China 11+1+0 (12)
Columbia 1+0+0 (1)
Congo 1+0+0 (1)
Egypt 5+0+0 (5)
Europe 105+3+8 (116)
French Guyana 2+0+0 (2)
Gabon 2+0+0 (2)
Galapagos 3+0+0 (3)
Ghana 13+0+0 (13)
Guatemala 2+0+0 (2)
Guyana 1+0+0 (1)
Hong Kong 1+0+0 (1)
India 27+3+0 (30)
Iran 4+0+0 (4)
Iraq 11+0+0 (11)
Israel 31+0+0 (31)
Japan 4+1+0 (5)
Jordan 3+0+0 (3)
Kenya 27+0+0 (27)
Lebanon 5+0+0 (5)
Madagascar 25+0+0 (25)
Malawi 14+0+0 (14)
Malaya 1+0+0 (1)
Mali 3+0+0 (3)
Mauritania 11+0+0 (11)
Morocco 12+0+0 (12)
Moçambique 2+0+0 (2)
New Zealand 5+1+0 (6)
Niger 15+0+0 (15)
Nigeria 41+0+0 (41)
Oman 22+0+0 (22)
Pakistan 13+0+0 (13)
Peru 5+0+0 (5)
S. Africa 26+0+0 (26)
Saudi Arabia 37+0+0 (37)
Sierra Leone 2+0+0 (2)
Socotra 12+0+0 (12)
Sri Lanka 1+0+0 (1)
Sudan 13+0+0 (13)
Taiwan 1+0+0 (1)
Tanzania 48+0+0 (48)
Trinidad 4+0+0 (4)
Tunisia 1+0+0 (1)
Turkey 28+0+0 (28)
UAE 11+0+0 (11)
Uganda 2+0+0 (2)
USA 22+3+1 (26)
Venezuela 0+1+0 (1)
W. Pacific Fringe 17+2+0 (19)
Yemen 18+0+0 (18)
Zaïre 4+0+0 (4)
Zambia 11+0+0 (11)
Zanzibar 2+0+0 (2)
Zimbabwe 29+0+0 (29)

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REPORT ON AN INFORMAL DISCUSSION ON CURRENT AND FUTURE PROJECTS AND RESEARCH THEMES IN NEUROPTEROLOGY

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Until 1980 communication between neuropterologists was almost entirely restricted to individual personal contacts, and at an international level only very few knew each other personally. In September 1980 the First International Symposium on Neuropterology was held in Graz (Austria), and from this time onwards international contacts were significantly improved, particularly also as a result of the subsequent international symposia in Hamburg, Germany (1984), Berg-en-Dal, South Africa (1988), Bagnères-de-Luchon, France (1991), Cairo, Egypt (1994), Helsinki, Finland (1997), and Budapest, Hungary (2000).

In addition, two newsletters devoted to Neuropterida were founded: the Neuropterists Newsletter of the International Association of Neuropterology (edited by N. D. PENNY) with 9 issues (1981–1999) and Neuro News (edited by C. W. PLANT) with 26 issues (1988–2000). These newsletters have greatly contributed to mutual information.

Several additional significant steps forward were taken by establishing access to information in our field in the Internet. The following addresses are particularly important:

– http://entowww.tamu.edu/research/neuropterida/neuroweb.html;
– forum@neuroptera.com.

Nevertheless, much information on projects being carried out or planned remains unknown and is unavailable, unless general discussions are held during the symposia, and questionnaires distributed which may largely overcome this lack of information.

During the last three symposia (Bagnères-de-Luchon, Cairo, Helsinki) Round Table discussions on current projects and co-operation in our field were held. Brief reports on these discussions were published in the Proceedings of these symposia (ASPÖCK 1992, ASPÖCK *et al.* 1996, ASPÖCK & CANARD 1998), which stimulated much interest among neuropterologists, particularly among those colleagues who had not been able to attend the conferences.

The main purposes of these Round Table discussion should again be emphasised: 1) broad mutual information, 2) improvement of strategies for current and future projects, 3) avoidance of unnecessary (usually unintentional) competition resulting in waste of time by duplication of work and, 4) stimulating co-operation, establishing useful contacts and initiating joint projects.

About three months before the symposium questionnaires were sent to all neuropterologists collect information on current and planned projects on one hand and intended co-operation on the other. Only a few responses were received. In July the questionnaires were sent out again so that, finally, information was obtained from the majority of the scientific community of neuropterologists. These data were presented in Budapest and supplemented by those collected during the symposium and by additional information obtained after the symposium.

A summary of the present state of current (or recently completed) and planned projects is presented here. We apologize in advance for any mistakes resulting from misunderstanding .

NEUROPTERIDA

U. ASPÖCK (in co-operation with J. D. PLANT and H. L. NEMESCHKAL) has undertaken a cladistic study of Neuropterida (and of Neuroptera, in particular) that has recently been published (ASPÖCK *et al.* 2001). She is continuing these studies, particularly with regard to investigations on homologies of genital structures in Neuropterida.

M. ENGEL has been carrying out cladistic studies based on combination of neontological and palaeontological data.

S. WINTERTON has been studying the phylogeny of Neuropterida by means of a combination of morphological and molecular biological data.

GY. SZIRÁKI has been continuing his studies on female genitalia of Neuropterida.

U. ASPÖCK and H. ASPÖCK are preparing a review of Neuropterida for a new edition of A. KAESTNER's textbook "Lehrbuch der Speziellen Zoologie".

Fossils of Neuropterida are being studied by several investigators: R. DOBOSZ (Baltic Amber, in co-operation with W. KRZEMIŃSKI); M. ENGEL; V. N. MAKARKIN (materials of the Palaeontological Institute, Moscow); A. NEL (Amber from Paris Basin/Late Eocene; Upper Cretaceous of France; Late Cretaceous of Lebanon).

V. N. MAKARKIN (possibly together with J. ANSORGE and A. PONOMARENKO) is planning an "Annotated catalogue of the fossil Neuropterida of the world".

H. ASPÖCK, H. HÖLZEL and U. ASPÖCK have completed an "Annotated Catalogue of the Neuropterida of the Western Palaearctic" (that was published in 2001).

The project on the Neuropterida of northern and northwestern Europe by H. ASPÖCK, U. ASPÖCK, J. GEPP, L. GREVE, N. KRISTENSEN, M. MEINANDER and A. POPOV is still in progress.

The Neuropterida will be treated by U. ASPÖCK and H. ASPÖCK within the international project "Fauna Europaea".

H. ASPÖCK, U. ASPÖCK and H. HÖLZEL have initiated another book project: "The Neuropterida of the islands of the Mediterranean".

R. DOBOSZ is preparing keys for the identification of Polish Neuropteroidea.

Several colleagues have been studying regional faunas: W. CZECHOWSKA (Poland); D. DEVETAK (Balkan Peninsula); R. DOBOSZ (Poland, Turkey); P. DUELLI (Switzerland, with particular regard to phenological and chorological data using a computer program); A. GRUPPE (Germany, in particular Bavaria and SW Germany; Panama); A. LETARDI (Italy); M. W. MANSELL (South Africa in particular, and the Afrotropical Region in general, based on the electronic Southern African lacewing monitoring programme; see below); R. PANTALEONI (Italy); C. W. PLANT (Great Britain); A. POPOV (Catalogue of Neuropterida of Denmark including bibliography, distribution and distributional maps, phenology; Finland; Sweden; Bulgaria); W. RÖHRICHT (Northern, Eastern and Central Germany); CH. SAURE (Northern Germany; moreover, he has been preparing a catalogue of the Neuropterida of Germany within the project "Entomofauna Germanica"); E. J. TRÖGER (SW Germany, Crete); A. WHITTINGTON (Scotland); A. ZAKHARENKO (Ukraine, Caucasus, Jordan, Central Asia).

M. W. MANSELL has established a long-term project: Southern African lacewing monitoring programme, with five operational components: biodiversity audit (collecting and curation); systematic revisions and phylogenetic analysis; larval biology and ecological requirements; distribution patterns and predictive modelling; conservation status and protective measures.

A. GRUPPE is working on the Neuropterida of canopies in Germany and in Panama, and he is planning further projects on Neuropterida in canopies in Romania, Slovenia and Malaysia.

J. OSWALD and M. OHL are compiling an annotated catalogue of the types of Neuropterida preserved in the Museum für Naturkunde, Institut für Systematische Zoologie der Humboldt-Universität, Berlin.

J. OSWALD has been continuing his work on the TIARA Biodiversity Project (http://www.csdl.tamu.edu/tiara/) and the Bibliography of the Neuropterida (see Internet). Both are large projects that require continuing efforts.

A. WHITTINGTON has been preparing a catalogue of the types of Neuropterida preserved in the National Museum of Scottland. He also intends to publish a synopsis of Neuropterida in Scotland.

J. KUBRAKIEWICZ (together with S. M. BILINSKI) has been studying the structure of ovaries in several families, particularly with respect to phylogenetic conclusions.

A. LETARDI is continuing his studies on the history of research on Neuropterida by Italian authors. He is working on a zoogeographical analysis of the Neuropterida of Italy.

H. ASPÖCK is permanently collecting data on history of research on Neuropterida.

RAPHIDIOPTERA

U. ASPÖCK and H. ASPÖCK (in co-operation with J. D. PLANT) are preparing a computerized cladistic study. Another study on the classification of Raphidioptera based on molecular biological data has been initiated (joint-project with E. HARING).

H. ASPÖCK, U. ASPÖCK and H. RAUSCH are continuously carrying out revisional work with Raphidioptera from all parts of the world.

V. MONSERRAT is supervising a thesis on female genitalia of the Raphidioptera of the Iberian peninsula.

M. ENGEL is evaluating fossil Raphidioptera from the Lower Cretaceous of China.

Raphidiidae

H. ASPÖCK, U. ASPÖCK and H. RAUSCH are permanently working on the taxonomy of adults as well as of larvae of Raphidioptera on a world-wide level, especially on species occurring in Central Asia.

Inocelliidae

H. ASPÖCK, U. ASPÖCK and H. RAUSCH are presently studying the Inocelliidae of Eastern Asia and preparing a review paper.

MEGALOPTERA

M. ENGEL is completing a monograph of the Oligocene–Miocene Mexican and Dominican amber Megaloptera fauna.

A. CONTRERAS-RAMOS is working on the Megaloptera of Venezuela (descriptions of new species of *Corydalus, Chloronia*, and *Sialis*). He is also planning a summary of taxonomic knowledge of the Megaloptera of Costa Rica (with emphasis on immatures), an illustrated guide for the identification of the Megaloptera of Venezuela, and studies on mating behaviour of Mexican Corydalinae.

A. LETARDI is planning taxonomic studies on Asian Corydalidae.

K. WISE is investigating the Megaloptera of New Zealand.

F. HAYASI has been collecting data on larvae of all Japanese Megaloptera; he is also continuing his studies on mating behaviour of Megaloptera.

Sialidae

T. VOLKOVICH intends to study life cycles of Sialidae in Russia.

NEUROPTERA

U. ASPÖCK has completed and published a computerized cladistic study (ASPÖCK *et al.* 2001) and is now carrying out a DNA-based cladistic study (together with E. HARING).

GY. SZIRÁKI is working on evolution of Neuroptera.

M. W. MANSELL is running an electronic "Catalogue of Southern African and Afrotropical Neuroptera", Moreover, he has (together with B. KENYON) developed a relational electronic database, called "Palpares Relational Database", which comprises a set of inter-linked tables and forms that contains specimen data, taxonomy, localities, bibliography, institutions, persons, queries and graphics.

F. HAYASI is studying and describing larvae of aquatic and semiaquatic Neuroptera of Eastern Asia.

M. and C. TAUBER are working on the comparative biology and systematics of the New World fauna.

V. MAKARKIN is continuously studying fossil Neuroptera of various periods.

M. ENGEL is completing a monograph of the Oligocene-Miocene Mexican and Dominican amber Neuroptera fauna.

A. NEL is investigating fossils from the Mesozoic.

Various colleagues are studying the Neuroptera of certain regions (see also under Neuropterida): W. CZECHOWSKA (Poland); A. CONTRERAS-RAMOS, J. OSWALD & N. PENNY (Mexico); S. DE FREITAS (Neotropical Region); R. GÜSTEN (Tunisia, Sokotra); M. W. MANSELL (southern Africa); N. PENNY (together with K. HOFFMANN, M. MEINANDER, V. MONSERRAT & L. STANGE) (Costa Rica); A. POPOV (Bulgaria); K. WISE (New Zealand).

T. NEW is preparing a handbook on the Neuroptera of Malesia.

M. and C. TAUBER are planning a publication on the comparative biology and systematics of the Hawaiian lacewings.

J. GEPP is continuing his studies on larvae of Central European Neuroptera, and also on the phenology of alpine Neuroptera.

R. PANTALEONI is collecting data on the chorology of Neuroptera occurring in Italy.

A. LETARDI is studying the Neuroptera of particular habitats (hedgerows of agroecosystems; wet area near the coast of Latium).

P. MCEWEN, T. NEW & A. WHITTINGTON are editors of a book on "Lacewings in the crop environment" with contributions of many authors, that was published in 2001).

M. CANARD, R. PANTALEONI and M. PAULIAN have initiated a research project on Neuroptera in wetlands.

W. CZECHOWSKA is carrying out an ecological research project on the structure of neuropteran communities in canopies of typical forest associations.

F. SZENTKIRÁLYI intends to carry out studies on natural enemies (mainly parasitoids) of Neuroptera.

D. DEVETAK is studying ecophysiology of mechanoreceptions in various Neuroptera (see under Chrysopidae, Mantispidae, Myrmeleontidae).

Nevrorthidae

U. ASPÖCK and H. ASPÖCK are working on a world-wide revision of the family.

Polystechotidae

J. OSWALD is preparing a taxonomic review of the family.

Osmylidae

S. WINTERTON is revising the morphological characters of the genera of Osmylidae of the world with respect to the phylogeny and classification of the family.

Chrysopidae

H. HÖLZEL has been continuously working on a catalogue of the Chrysopidae of the Afrotropical Region.

V. MONSERRAT has been collecting data for a monograph of the Chrysopidae of the Iberian Peninsula.

R. DOBOSZ is working on a monograph of the Chrysopidae of Poland.

T. NEW is continuing his revision of the Chrysopidae of Southeast Asia.

H. HÖLZEL and the late P. OHM have revised the Chrysopidae of the Madagascan subregion. (They have published a paper: HÖLZEL & OHM 2000.)

The late P. OHM and H. HÖLZEL prepared a paper on the Chrysopidae of northern Africa.

R. PANTALEONI is investigating the taxonomy of Dichochrysa.

N. PENNY (together with S. DE FREITAS) has been carrying out a research project on Chrysopidae in agro-ecosystems in Brazil. Moreover, he is studying new genera of Neotropical Chrysopidae (also together with S. DE FREITAS), furthermore (together with C. TAUBER) describing new species of *Chrysopa* and *Ceraeochrysa* respectively N. PENNY and S. DE FREITAS are planning to complete the Chrysopidae part of the series on Neuroptera of the Amazon Basin, with papers on the Apochrysinae, Belonopterygini and Leucochrysini.

N. PENNY and C. TAUBER intend to do a revision of *Ceraeochrysa*.

M. and C. TAUBER are continuing their studies on New World Chrysopidae, they are also planning a larger publication on the New World Chrysopini, with emphasis on the generic characteristics of the larvae.

A. NEL (together with X. MARTINEZ-DELCLOS) is evaluating fossil Chrysopidae from the late Cretaceous of Spain, of Brazil, and of China.

S. WINTERTON is planning a project "Molecular phylogeny of the Chrysopidae".

YANG XINGKE is preparing the chapter on Chrysopidae within the "Fauna Sinica".

Several authors are studying the Chrysopidae of certain regions, partly under special aspects: A. BOZSIK (Belgium; sibling species of the *Chrysoperla carnea* complex in Hungary and Belgium); S. BROOKS (together with C. S. HENRY) (sys-

tematics of the *Chrysoperla carnea* complex in Western Europe); M. CANARD (together with R. CLOUPEAU, M. JARRY, A. MIRMOAYEDI, M. PAULIAN and D. THIERRY) (*Chrysoperla carnea* complex in Europe and the Near East); S. DE FREITAS (Brazil: adults, larvae); R. DOBOSZ (Poland); P. DUELLI (distribution of the species of the *Chrysoperla carnea* complex and detection of new song morphs in Eurasia and Europe and providing distribution maps for all known sibling species); L. JEDLICKA (*Chrysoperla carnea* complex in Slovakia); J. B. JOHNSON (together with C. HENRY, P. DUELLI and S. BROOKS) (taxonomy and ecology of the species of the *Chrysoperla carnea* complex); M. PAULIAN (Romania); C. W. PLANT (*Chrysoperla carnea* complex in British Isles); M. and C. TAUBER (Hawaii: evolution, systematics and comparative biology of *Anomalochrysa*).

D. THIERRY intends to extend his studies on the *Chrysoperla carnea* complex to the whole genus.

R. PANTALEONI is studying parasites of Chrysopidae with particular reference to the taxonomy of Heloridae and the biology of *Telenomus*.

D. DEVETAK (together with S. LIPOVŠEK and M. A. PABST) is investigating structure, ultrastructure, physiology and biophysics of scolopidial organs in *Chrysoperla carnea* s. l.

A. BOZSIK is studying feeding habits of adult Chrysopidae in Hungary as well as side-effects of pesticides on green lacewings with special emphasis on the *Chr. carnea* complex.

M. CANARD is studying Chrysopidae in agrosystems.

C. F. CARVALHO and S. DE FREITAS are investigating the possible significance of *Chrysoperla externa* in biological control.

M. A. M. VENTURA is studying Azorean Chrysopidae with respect to their potential role in biological control and integrated pest management. Moreover, she has (together with colleagues from Europe and USA) started a programme to investigate the provenance of the representatives of the *Chrysoperla carnea* complex occurring on the Azores.

F. SZENTKIRÁLYI is continuing his long-term project on light trap monitoring. Moreover, he is planning a project on toxic effects of transgenic Bt-maize to lacewings.

S. A. EL ARNAOUTY is carrying out mass rearing of *Chrysoperla carnea* (s. l.) and release in greenhouses and in the field for control of aphids.

S. HASSAN is doing some research on mass rearing and various application methods.

D. THIERRY (together with E. RAT-MORRIS and with C. TROUVÉ respectively) is working on the efficiency of Chrysopidae for Integrated Pest Management, in particular in the protection of leek and in vegetable crops.

M. and C. TAUBER are studying the various possibilities and aspects of commercialisation of Chrysopidae in particular also species of *Ceraeochrysa*, *Plesiochrysa* and *Leucochrysa*, as biological control agents.

T. VOLKOVICH is working on physiology and ecology of Chrysopidae, in particular she is studying life cycles of Chrysopidae of Eastern Europe.

A. KOVRIGINA is planning a faunistic and ecological review of the Chrysopidae of Russia.

D. THIERRY (together with M. MOULOUD and P. SIMO) is investigating enzyme polymorphism of species of the *Chrysoperla carnea* complex used in integrated pest control.

C. F. CARVALHO is planning studies on the population dynamics of Chrysopidae species on coffee tree, fruit trees, corn and vegetables in the south of the State of Minas Gerais (Brazil) and, simultaneously, a catalogue of the species of the family occurring in this part of Brazil.

Hemerobiidae

J. OSWALD has been describing new species from various parts of the world.

M. and C. TAUBER have been working on the evolution, systematics and comparative biology of Hawaiian species of *Micromus*.

S. DE FREITAS is studying the Hemerobiidae of Brazil.

A. MIRMOAYEDI (together with A. ZAKHARENKO) is investigating the Hemerobiidae of Iran.

M. PAULIAN is studying the role of Hemerobiidae in plant protection.

C. W. PLANT is particularly interested in documenting the phenology and voltinism of the British species.

F. SZENTKIRÁLYI continues his long-term project on light trap monitoring.

H. ASPÖCK has begun with a documentation of the history of research on the family.

Sisyridae

W. WEISSMAIR has been studying the family from various aspects, particularly the taxonomy of adults and larvae and biology.

C. SMITHERS is carrying out a revision of the Sisyridae of Australia.

Coniopterygidae

M. MEINANDER (presently mayor of Helsinki) had to interrupt his work on Coniopterygidae for the next three years, but intends to continue later.

GY. SZIRÁKI has been continuously working on the taxonomy on a world-wide level, in particular, he is studying material from Europe, Asia and Africa. He is planning a review of the Coniopterygidae of Arabia and, later, another covering Asia, Europe, and Northern Africa.

A. MIRMOAYEDI (in co-operation with A. ZAKHARENKO) is studying the Coniopterygidae of Iran.

H. ASPÖCK is documenting early publications on Coniopterygidae and the history of research on the family.

Dilaridae

R. PANTALEONI is investigating the biology of *Dilar parthenopaeus*.

Mantispidae

M. OHL intends to carry out a revision of all genera of the family and of the species occurring in the Palaearctic region.

A. E. WHITTINGTON has started with studies on African Mantispidae.

S. DE FREITAS is studying Mantispidae of Brazil.

T. NEW continues his studies on Asian Mantispidae.

D. DEVETAK (together with K. KRAL) is continuing studies on visual orientation in the predatory behaviour of *Mantispa styriaca*.

Berothidae

U. ASPÖCK and H. ASPÖCK are continuing their revisional work of the family on a world-wide level.

M. ENGEL is studying fossil material from Baltic Amber.

P. E. SPIEGLER intends to carry out further studies on the biology of *Lomamyia*.

Rhachiberothidae

U. ASPÖCK and H. ASPÖCK are always ready to study and identify material with the goal of a summarizing publication on the family in a few years.

MYRMELEONTIFORMIA

J. OSWALD is studying the phylogeny of the families of this suborder.

Nemopteridae

M. W. MANSELL continues his studies on Nemopteridae, with special attention to the genera *Nemia* and *Nemopterella*.

A. MIRMOAYEDI (in co-operation with M. MANSELL) is studying the Nemopteridae of Iran.

J. OSWALD is reviewing the genus *Stenorrhachus*.

Nymphidae

J. OSWALD is revising the family and investigating its phylogeny.

Myrmeleontidae

V. KRIVOKHATSKY is studying the muscles of male genitalia. Moreover, he is continuing to describe new species from different parts of the world. He is particularly interested in the fauna of Russia, and he plans to write the chapter on Myrmeleontidae in the "Fauna of Russia and adjacent countries".

M. MANSELL continues his research in Afrotropical Myrmeleontidae, with special emphasis on the southern African fauna; taxa of particular interest are *Crambomorphus*, *Golafrus*, *Lachlathetes*, the *speciosus*-group of *Palpares* (for which a new genus will have to be described), and the Isonemurini.

J. OSWALD is working on the taxonomy of North American *Myrmeleon* species on one hand and on the phylogeny of the family on the other.

A. MIRMOAYEDI (together with V. KRIVOKHATSKY) studies Myrmeleontidae of Iran.

R. PANTALEONI is studying the taxonomy of larvae of the genus *Myrmeleon*.

S. DE FREITAS is interested in the taxonomy of Myrmeleontidae of Brazil.

H. HÖLZEL is continuing his revisional studies on the Myrmeleontidae of the Arabian Peninsula.

N. PENNY and L. STANGE are planning a revision of the genus *Visca* (Madagascar).

W. RÖHRICHT continues to collect faunistical data on *Myrmeleon bore*.

F. SZENTKIRÁLYI is continuing his long-term project on light trap monitoring.

A. KOVRIGINA is planning a study on the biology and distribution of *Grocus bore* in the Samara Region (Russia).

D. DEVETAK (together with B. MENCINGER) is investigating detection and recognition of prey in ant-lions.

Ascalaphidae

V. KRIVOKHATSKY is preparing the chapter on Ascalaphidae in the "Fauna of Russia and adjacent countries".

H. HÖLZEL continues his studies on the Ascalaphidae of the Arabian Peninsula.

A. PROST is studying the Ascalaphidae of West Africa.

M. MANSELL is continuing his work on Ascalaphidae of South Africa, particularly with respect to the discovery, rearing and correlating larvae.

A. LETARDI is planning taxonomic studies on Ascalaphidae of subsaharan Africa.

GY. SZIRÁKI continues his taxonomic studies on Ascalaphidae of Asia, and would be interested in a co-operation.

O. FLINT will describe a new species of *Pseudoptynx* from Sri Lanka.

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POST-SYMPOSIUM NEUROPTEROLOGICAL EXCURSION IN HUNGARY, 10–15 AUGUST, 2000

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INTRODUCTION

The post-symposium excursion though central and south-west Hungary, provided members of the Seventh International Symposium on Neuropterology with an opportunity to collect Neuroptera in a variety of interesting and unusual habitats. Furthermore, it prolonged the four-day symposium by six days, giving attendees the chance to integrate socially and scientifically, distil new ideas and projects and to further their joint interests.

The purpose of this report is to place on record the route followed (Fig. 1) and the location of the 14 collecting points along that route, including the location of the Symposium, the Leisure Centre at Csillebérc, Budapest. A list of 40 species collected and determined by some of the members on the excursion (Table 1), and compiled from submissions by participants, is also provided. The total number of species known for Hungary was listed at 109 species (SZIRÁKI *et al.* 1992), but probably needs revising to about 112 species (SZENTKIRÁLYI *pers. comm.*). The *Chrysoperla carnea* (STEPHENS, 1836) species group was not treated equally by all collectors submitting reports. It has consequently been recorded firstly as an aggregate and then as the species segregates identified in some submissions.

Although no new taxa were recorded for the area, the list of 40 species is good for the end of season. These data provide additional distribution records for the growing number of records amassed by scientists working on Neuroptera in Hungarian Institutions, although many of the sites visited are already well known to them and previously surveyed. Nonetheless, the fauna was unfamiliar to many of the participants from abroad and this was a unique opportunity to collect species previously not encountered.

The bulk of the collecting was by beating and sweeping vegetation, both highly successful methods for collecting Neuroptera. Supplementing these methods, Mercury Vapour light traps were erected at two locations at Uzsai csárabos erdő Protected Area and at Kaszópuszta, resulting in 7 and 14 species per site. The

sites are listed numerically below and are reflected on Table 1. Total species per site are also provided in Table 1, with the highest totals being recorded at locations where more than one day was spent at the site (Csillebérc and Kaszó-puszta), or where the fauna was known to be unusually rich (mixed deciduous-oak woodland and lucerne fields at Tóti-hegy).

The greater diversity and abundance of the Chrysopidae over other families is significant. The *Chrysoperla carnea* (STEPHENS, 1836) complex was particularly widespread, followed closely by *Chrysotropia ciliata* (WESMAEL, 1841). Collecting *Sisyra fuscata* (FABRICIUS, 1793) and *Mantispa perla* (PALLAS, 1772) at light traps (the latter from the ground near a "black-light"), and *Sisyra* spp. from riverine vegetation were highlights of the trip.

COLLECTING SITES

The manner in which collecting sites were recorded by collectors was not consistent. The following list is consequently a harmonised combination of those

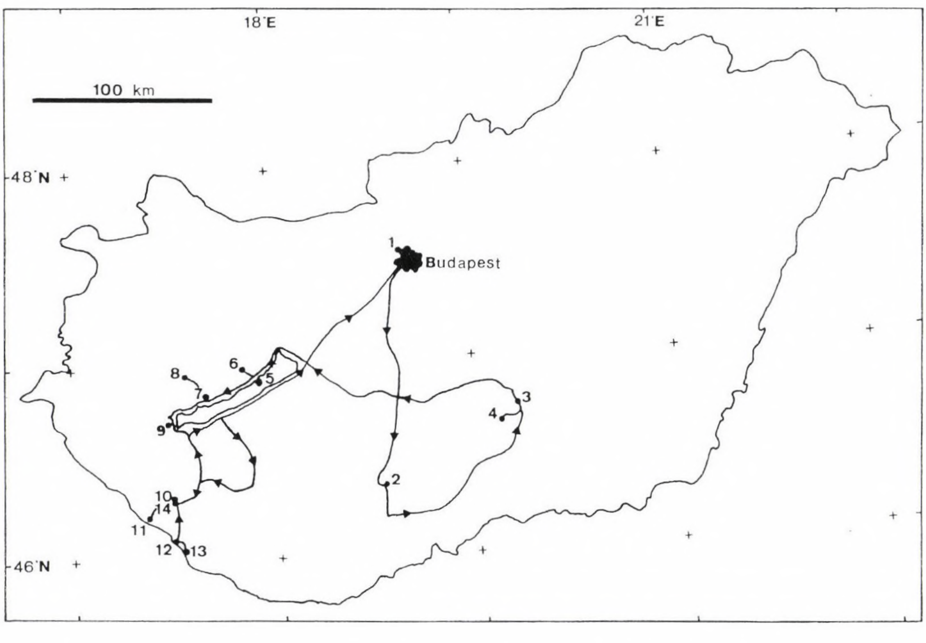


Fig. 1. Route of the Neuropterological excursion in Central Hungary, 10–15 August 2000. Numbers along the route indicate sequential collecting sites as listed in text

records and represents the stopping points along the route. Minor (one-off) collections by individuals, at places in between these sites have not been taken into account here. Most of the co-ordinates were taken from a *Garmin GPS 38 Personal Navigator*™ and have been rounded to the nearest minute.

1. Budapest, Csillebérc (Budai-hegység, between 400–500 m a.s.l.). 05–09 August 2000 – Leisure Centre set in mixed deciduous woodland (mainly *Quercus cerris* and *Q. petraea* mixed with hornbeam, or beech in northern cooler and wetter slopes) including material collected at Normafa (47°30'N 18°58'E). Swept, beaten and at lights.

2. Tolna county, Duna–Dráva National Park, Szekszárd, Gemenci-erdő, river bank of Duna (46°26'N 18°47'E). 10 August 2000 – Riverine gallery forest in the Duna (=Danube) river valley (original vegetation fragments: *Quercus robur* mixed with *Fraxinus excelsior*, *Ulmus* and poplars with rich bushy vegetation; recently planted poplars). Swept and beaten.



Figs 2–3. 2 = H. ASPÖCK and U. ASPÖCK at Bugac; 3 = Participants on the top of the hill Tóti-hegy; 4 = Participants on the bank of the river Dráva; 5 = P. OHM at Bugac

Table 1. Genera and species recorded during the Neuropterological excursion in Hungary, 10–15 August 2000. Abbreviation: 1 = Csillebérc, 2 = Gemenci-erdő, 3 = Kunszállás, 4 = Bugacpuszta, 5 = Tihanyi-félsziget, 6 = Vászoly, 7 = Tóti-hegy, 8 = Uzsai csarabos erdő, 9 = Fenékpuszta, 10 = Kaszópuszta, 11 = Lankócpuszta, 12 = Bélavár, 13 = Vízvár, 14 = Baláta-tó

	Site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CHRYSOPIDAE														
Chrysopa abbreviata CURTIS, 1834			+											
C. dorsalis BURMEISTER, 1839								+						
C. formosa BRAUER, 1850	+	+	+											
C. pallens (RAMBUR, 1838)	+	+	+		+					+				
C. perla (LINNAEUS, 1758)	+		+								+			
C. phyllochroma WESMAEL, 1841							+							
C. walkeri MCLACHLAN, 1893							+							
Chrysoperla carnea (STEPHENS, 1836) complex	+	+	+	+	+		+	+	+	+	+	+	+	+
"*C. carnea* complex" "slow motorboat" "morph (=Cc2)"		+	+	+			+							
"*C. carnea* complex" "*kolthoffi*" "morph (=Cc4)"	+		+	+			+	+				+		
C. lucasina (LACROIX, 1912)			+											
Chrysotropia ciliata (WESMAEL, 1841)		+			+		+	+		+	+	+	+	+
Dichochrysa flavifons (BRAUER, 1850)	+						+							
D. prasina (BURMEISTER, 1839)	+	+			+		+			+	+			
D. ventralis (CURTIS, 1834)	+						+	+		+				
Nineta flava (SCOPOLI, 1763)							+							
N. guadarramensis (PICTET, 1865)							+							
N. principiae MONSERRAT,1980	+													
Nothochrysa fulviceps (STEPHENS, 1836)	+				+		+							
CONIOPTERYGIDAE														
Coniopteryx lentiae ASPÖCK et ASPÖCK, 1964	+						+							
C. pygmaea (ENDERLEIN, 1906)	+													
Conwentzia psociformis (CURTIS, 1834)	+									+				
Semidalis aleyrodiformis (STEPHENS, 1836)	+									+	+			
HEMEROBIIDAE														
Hemerobius gilvus STEIN, 1863	+				+		+			+				
H. humulinus LINNAEUS, 1758	+	+					+							

Table 1 (continued)

	Site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
H. lutescens FABRICIUS, 1793	+													
H. micans OLIVIER, 1792	+	+					+			+	+			
H. nitidulus FABRICIUS, 1777	+													
Micromus angulatus (STEPHENS, 1836)							+			+				
M. lanosus (ZELENÝ, 1962)	+													
M. variegatus (FABRICIUS, 1793)	+									+				
Psectra diptera (BURMEISTER, 1839)								+		+				
Sympherobius elegans (STEPHENS, 1836)										+				
MANTISPIDAE														
Mantispa perla (PALLAS, 1772)								+						
MYRMELEONITDAE														
Euroleon nostras (FOURCROY, 1785)	+					+								
Creoleon plumbeus (OLIVIER, 1811)				+										
Myrmecaelurus trigrammus (PALLAS, 1781)	+		+	+										
Myrmeleon inconspicuus RAMBUR, 1842				+										
SISYRIDAE														
Sisyra fuscata (FABRICIUS, 1793)										+		+	+	
S. terminalis CURTIS, 1855												+	+	
Totals	23	8	9	6	6	1	17	7	1	14	6	5	4	2

3. Bács–Kiskun county, Kunszállás (46°44'N 19°45'E). 10 August 2000 – Dry fallow agricultural fields near to and in the grounds of Róna Panzió Hotel. Sandy soil. Swept, beaten and at lights.

4. Bács–Kiskun county, Kiskunsági National Park, Bugacpuszta (46°39'N 19°37'E). 11 August 2000 – Juniper-white poplar mixed forest (Juniperetum: *Juniperus communis*, *Populus alba*) and planted *Pinus sylvestris* stands on sand dune substrate. Swept and beaten (Fig. 2).

5. Veszprém county, Balaton-Felvidéki National Park, Tihanyi-félsziget, a peninsula at Lake Balaton (46°55'N 17°50'E). 11 August 2000 – Meadows and wooded walk to the hills Nyereg-hegy and Csúcs-hegy. Mixed deciduous dry oak forest with rich bushy vegetation on volcanic substrate. Swept and beaten.

6. Veszprém county, Balaton-Felvidéki National Park, Vászoly (46°56'N 17°20'E). 11 August 2000 – Agricultural pasture and mixed woodland. Domestic lights.

7. Veszprém county, Balaton-felvidéki National Park, Káptalantóti, Tóti-hegy, 3 km W from Salföld (46°50'N 17°33'E). 12 August 2000 – Mixed dry deciduous-oak woodland (mainly *Quercus cerris* and *Q. pubescens*) with scattered xerothermous grassy patches (Fig. 3). At the wetter base of the hill, mixed oak-hornbeam forest and lucerne fields. Swept and beaten.

8. Veszprém county, Sümeg, Uzsai csarabos erdő Protected Area, 5 km SE of Sümeg (46°56'N 17°20'E). 12 August 2000 – Mixed dry birch-oak woodland (*Quercus cerris* and *Q. pubescens*) and plantations of *Pinus sylvestris* and *P. nigra* and scattered patches of grass and *Calluna vulgaris*. Sauer soil on sand-conglomerate. Swept, beaten and at light trap with use of 125W Mercury-vapour bulb, 21h00–24h00.

9. Zala-county, Keszthely, Fenékpuszta, 4 km S of Keszthely (ca. 46°40'N 17°15'E). 13 August 2000 – Fourth century Roman ruins. Unmanaged meadow with ruderal vegetation and agricultural lands. Swept.

10. Somogy county, Somogyszob, Kaszópuszta, 7 km NW of Somogyszob (46°19'N 17°14'E). 13 August 2000 – Mixed birch-oak woodland and *Pinus sylvestris* plantations on sandy soils. Swept, beaten and at light trap (125 W mercury vapour bulb), 21h00–24h00.

11. Somogy-county, Duna–Dráva National Park, Gyékényes, Lankócpuszta (5 km SE of Gyékényes) (46°13'N 17°03'E). 14 August 2000 – Canopy mixed oak woodland (*Q. robur, Fraxinus*) on wet soils of lowland. Swept and beaten.

12. Somogy county, Duna–Dráva National Park, Bélavár, river bank of Dráva (46°07'N 17°12'E). 14 August 2000 – Dráva river and riverine gallery forest (Fig. 4), also few smaller patches of half-opened sand-grassland vegetation, maize fields. Swept and beaten.

13. Somogy county, Duna–Dráva National Park, Vízvár, river bank of Dráva (46°05'N 17°14'E). 14 August 2000 – Dráva river and riverine gallery forest. Swept and beaten.

14. Somogy county, Szenta, Baláta-tó (Lake Baláta) Protected Area, 1 km SW of Kaszópuszta (46°18'N 17°13'E). 15 August 2000 – Mixed old oak forest on wet sandy soil. Swept and beaten.

*

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SYMPOSIUM PROGRAMME

Sunday, August 6

15.00–18.30	Registration at the Csillebérc Leisure and Youth Centre
17.30	Get together party and opening of the symposium

Monday, August 7

8.00–12.00	Possibility to put up posters
9.00–9.30	Opening words of Timothy New, president of the International Association for Neuropterology at the beginning of the scientific part of the symposium
9.30–12.00	**Session 1** – Chairpersons: Meinander, M. & Flint, O. S.
9.30	Aspöck, H.: The biology of Raphidioptera: a review of present knowledge
10.10	Popov, A.: Neuropteroidea of Northern Europe
10.35	New, T.: Neuroptera of Wallacea
11.05	Popov, A.: Zoogeographical analysis of Neuroptera in Bulgaria
11.35	Mirmoayedi, A.: New findings on the Iranian Neuropteran fauna
12.00	Photographing
12.20–13.40	Lunch time
13.40–16.05	**Session 2** – Chairpersons: Oswald, J. D. & Popov, A.
13.40	Mansell, M.: The Palpares relational database: an integrated model for lacewing research
14.20	Ohm, P. & Hölzel, H.: Zoogeographical pattern of Madagascan Chrysopidae
15.00	Güsten, R.: Antlion assemblages of two arid habitats in Tunisia
15.25	Hölzel, H. & Ohm, P.: Patterns in the distribution of Afrotropical Chrysopidae
17.00–20.00	Sightseeing in Budapest

Tuesday, August 8

8.30–10.15	**Session 3** – Chairpersons: New, T. & Whittington, A. E.
8.30	Aspöck, U.: Homology of male genital sclerites in Neuropterida – an adventure
9.05	Sziráki, Gy.: Contribution to the knowledge of female internal genitalia of Neuroptera
9.35	Mansell, M., Erasmus, B.: Southern African biomes and the evolution of Palparini (Insecta: Neuroptera: Myrmeleontidae)
10.30–12.30	Round table discussion on phylogeny of Neuropteroidea Chairperson: Aspöck, U.
12.30–13.50	Lunch time
13.50–15.40	**Session 4** – Chairpersons: Canard, M. & Szentkirályi, F.
13.50	Paulian, M., Thierry, D., Canard, M.: Green lacewing community and biodiversity changes in agroecosystems: an upsetting perspective (Neuroptera: Chrysopidae)
14.20	Duelli, P.: Forest edges are biodiversity hotspots–also for Neuroptera
14.55	El Arnaouty, S.: Biological control of green peach aphid *Myzus persicae* by *Chrysoperla carnea* (Stephens) sensu lato (Neuroptera: Chrysopidae) on green peppers in greenhouses in Egypt
15.30–18.00	**Poster session**
	Bozsik, A.: Side-effect of zoocides on adult *Chrysoperla kolthoffi* sensu Cloupeau, or is it possible to correct toxicology data gained on *Chrysoperla carnea* (Stephens) sensu lato (Neuroptera: Chrysopidae)
	Bozsik, A.: Data on dispersion of different taxa of the *Chrysoperla carnea* complex in some parts of Europe (Neuroptera: Chrysopidae)
	Bozsik, A.: Diversity and similarity of sibling species of the *Chrysoperla carnea* complex (Neuroptera: Chrysopidae) in Hungary
	Bozsik, A, Mignon, J. & Gaspar, Ch.: The green lacewings in Belgium (Neuroptera: Chrysopidae)

Carvalho, C. F., Canard, M. & Alauzet, C.: Weight increase of *Chrysoperla mediterranea* (Hölzel, 1972) (Neuroptera: Chrysopidae) adults in function of feeding

Carvalho, C. F., Canard, M. & Alauzet, C.: Influence of density of *Chrysoperla mediterranea* (Hölzel, 1972) (Neuroptera: Chrysopidae) adults per rearing units on reproduction potential

Devetak, D.: Neuroptera in the Submediterrabean oak forests in Slovenia

Gepp, J.: Ecological studies on antlions (Myrmeleontidae) of the Kiskunság National Park

Krivokhatsky, V.: Musculature of male genitalia of antlions (Neuroptera: Myrmeleontidae)

Letardi, A.: Data about Italian Neuropterida on a web page

Letardi, A. & Migliaccio, E.: Neuropterida of the Abruzzi National Park

Lipovsek, S. & Mencinger, B.: Remarks on Neuroptera of the north-eastern part of Slovenia

Mansell, M. W.: Monitoring lacewings (Insecta: Neuroptera) in southern Africa

Mateus Ventura, M., Garcia, V. & Canard, M.: IPM arrangements: be aware that benefical chrysopids may be depressed by microbiological treatments with *Metarhizium* sp.

Paulian, M.: Recent additions to green lacewing fauna of Rumania (Neuroptera: Chrysopidae)

Plant, C.: Mapping the British Isles Neuropterida

Popov, A.: Autecology and biology of *Nemoptera sinuata* Olivier (Neuroptera: Nemopteridae)

Souza, B. & Carvalho, C. F.: Population dynamics and seasonability of *Chrasoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) in a citrus agroecosystem

Szentkirályi, F. & Kazinczy, L.: Seasonal flight patterns of antlions (Neuroptera: Myrmeleontidae) monitored by the Hungarian light trap network

Szentkirályi, F. & Krištín, A.: Lacewings and snakeflies (Neuroptera, Raphidioptera) as preys for bird nestlings in Slovakian forest habitats

Thierry, D., Mouloud, M., Chu, N. T., Simo Santalla, P. & Gillet, P.: Enzymes polymorphism in *Chrysoperla carnea* complex (Neuroptera: Chrysopidae)

Wednesday, August 9

8.30–9.50	**Session 5** – Chairpersons: Hölzel, H. & Mateus Ventura, M.
8.30	Trouvé, C., Thierry, D., Canard, M.: Lacewings (Neuroptera: Chrysopidae, Hemerobiidae) naturally occurring in agroecosystems in Northern France
8.50	New, T.: Prospects of extending use of Australian lacewings in biological control
9.10	Thierry, D., Rat-Morris, E., Caldumbide, C.: Preliminary data on the efficiency of artifical overwintering chambers for the members of the *Chrysoperla carnea* complex (Neuroptera, Chrysopidae)
10.00–12.15	**Session 6** – Chair persons: Mansell, M. & Thierry, O.
10.00	Aspöck, H.: Osmylidae: Illustrations in the early entomological literature and the discovery of early srages and clarification of the biology
10.40	Flint, O.: List of the primary Neuroptera types in the collection of the National Museum of Natural History, Smithonian Institution, USA
11.00	Pantaleoni, R., Letardi, A.: What is the real name of the Italian ascalaphid ?
11.15	Whittington, A.: Resources in Scottish neuropterology
11.35	Oswald, J.: Biological informatics in neuropterology
12.10–13.30	Lunch time
13.30–15.30	Round table discussion on current and further projects and research themes Chairperson: Aspöck, H.
15.45–18.00	Meeting of the Association and Closing of the symposium
19.00	Congress dinner

Thursday, August 10

8.45	Departure for the post congress tour

PARTICIPANTS

ASPÖCK, Prof. Dr. Horst (Vienna, Austria)
ASPÖCK, Assistant Prof. Dr. Ulrike (Vienna, Austria)
BOZSIK, Dr. András (Debrecen, Hungary)
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CARVALHO, Dr. Cesar, F. (Lavras, Minas Gerais, Brasil)
DEVETAK, Dr. Dušan (Maribor, Slovenia)
DUELLI, Dr. Peter (Birmensdorf, Switzerland)
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GÜSTEN, Dr. Robert (Mainz, Germany)
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LETARDI, Dr. Agostino (Roma, Italy)
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POPOV, Dr. Alexi (Sofia, Bulgaria)
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THIERRY, Dr. Dominique (Angers, France)
SZENTKIRÁLYI, Dr. Ferenc (Budapest, Hungary)
SZIRÁKI, Dr. György (Budapest, Hungary)
WHITTINGTON, Dr. Andrew E. (Edinburgh, Scotland, U.K.)

Registered but unavoidably absent

GEPP, Dr. Johannes (Graz, Austria)
KRIVOKHATSKY, Dr. Victor A. (Sankt Petersburg, Russia)
PLANT, Colin W. (Bishops Stortford, U.K.)



Participants of the Seventh International Symposium on Neuropterology (from left to right): Dominique Thierry, Cesar Carvalho, Dušan Devetak, Alinaghi Mirmoayedi, Michel Canard, Saška Lipovšek, Herbert Hölzel, Andrew Whittington, Martin Meinander, András Bozsik, Mervyn Mansell, Maria Mateus Ventura (hidden), Ulrike Aspöck, Wieland Röchricht, Horst Aspöck, Alexi Popov, György Sziráki, Peter Ohm, Agostino Letardi, Timothy New, Sayed El Arnaouty, Robert Güsten, Oliver Flint, André Prost, Ferenc Szentkirályi, John Oswald, Peter Duelli, Mihaela Paulian

INDEX OF GENERIC AND SPECIES NAMES OF NEUROPTERIDA

INDEX OF ANIMAL GENERA AND SPECIES OTHER THAN NEUROPTERIDA

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